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(54) Process for preweakening an automotive trim cover for an air bag deployment opening

(57) A process for preweakening the inside of an automotive trim piece cover layer 16 of various constructions by use of a laser beam 14 so as to enable formation of an air bag deployment opening in the trim piece formed at the time the air bag deploys. The laser beam 14 impinges the inside surface of the cover 16 to form a groove scoring 20 or spaced perforations to form a preweakening pattern. A robot arm may be used to move a laser generator so as to form the preweakening pattern. The laser beam 14 can be controlled in accordance with sensed conditions to achieve accurate preweakening, and may also be used to trim substrate panels and to perform other cutting operations.

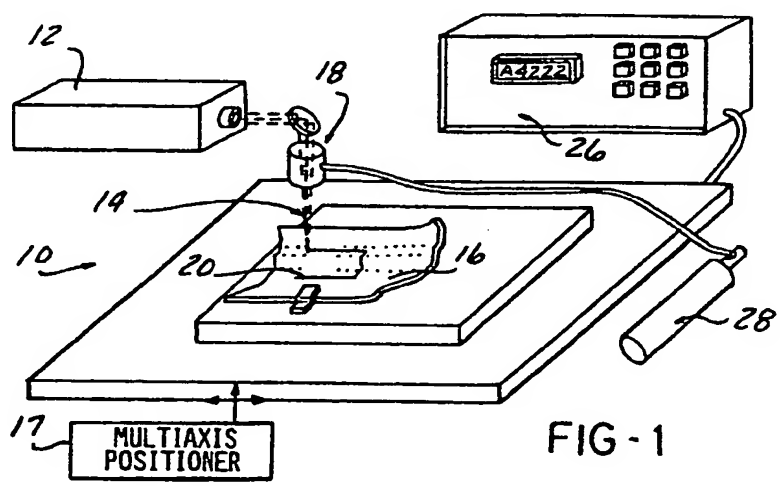


FIG - 1

EP 0 711 627 A2

Description

Field of the Invention

The present invention concerns cutting and scoring of covers for automotive trim pieces enclosing air bag safety devices.

Background of the Invention

Air bag safety systems have come into widespread use in automotive vehicles and light trucks and have been proposed for use in passenger trains and airplanes.

Such systems comprise an inflatable cushion, commonly referred to as an "air bag" which is stored folded in a storage receptacle and then very rapidly inflated, as with gas from a pyrotechnic gas generator, when a collision of the vehicle is detected by sensors. The air bag is thereby deployed in a position to absorb the impact of the driver or a passenger.

It is necessary that the folded air bag be stored in an enclosed secure environment within the passenger compartment, protected from tampering, and yet be allowed to properly deploy into the passenger compartment as the air bag is inflated.

It is critical that the air bag deploy within milliseconds of activation of the system in order to protect the occupant.

As noted, the air bag is enclosed within a storage receptacle, which is typically mounted behind an interior trim piece, such as a steering wheel cover in the case of the driver's side air bag, or a section of the instrument panel, in the case of the passenger's side air bag. It has been proposed to also provide side impact air bags in the vehicle doors.

One or more air bag deployment doors normally overlie the air bag receptacle and are forced open when the air bag is inflated to allow deployment of the air bag through the opening created by the door panel movement.

As described in U. S. Patent No. 5,082,310 issued on January 21, 1992 for an "Arrangement for Providing an Air Bag Deployment Opening", a seamless construction is advantageous in which the deployment door panels are not separately delineated within the expanse of the trim piece, but rather a smooth uninterrupted surface is provided extending over the deployment door substrate panels.

This construction necessitates severing portions of the covering of the trim piece in order to allow the door panels to hinge open.

Severing has been achieved by the pressure of the inflating air bag, or by various other methods which have been proposed, such as linear energy devices described in copending U. S. patent application Serial No. 08/279,225, filed July 22, 1994, attorney docket No. TIP-161. See also U. S. patent application Serial No. 08/027,114, filed March 4, 1993, and U. S. Patent Nos. 5,127,244 and 4,991,878 describing pyrotechnic elements used to cut the outer cover layer of the trim piece.

Cutter blades have also been proposed which are forced outwardly by the air bag inflation to assist in cutting the cover layer, but these outwardly swinging elements can present a potential hazard to a vehicle occupant seated in front of the deployment door.

Automotive interior trim covering materials such as vinyl plastic are relatively tough and difficult to sever, and also a predetermined severing pattern is necessary for proper door panel opening, such that heretofore preweakening grooves have been formed in the trim cover in a predetermined pattern to insure proper opening.

It has heretofore been proposed to provide an "invisible seam" installation in which the deployment door pattern is totally invisible to a person seated in the vehicle passenger compartment, and even faint outlines or "witness" lines are desirably avoided.

Scoring of the covering layer from the inside, if not done accurately, can over time become at least faintly visible from the exterior of the trim piece.

Fabrication of the automotive interior trim pieces with preweakening grooving particularly for invisible seam applications is thus a difficult manufacturing challenge.

First, the groove depth must be carefully controlled in order to achieve reliable rupture of the outer cover at exactly the right time during the air bag deployment event.

If the groove is too shallow, the thickness of the remaining material may be too great, presenting excessive resistance to severing, delaying air bag deployment. Conversely, if too little material remains, over time cracking may be result, or at least allow the appearance of externally visible "witness" lines.

The preweakening effect may also be less effective if the grooves are molded-in during the process since it has been found that cutting into plastic material such as vinyl has a better preweakening effect compared to molding-in the groove during the initial manufacture of the item.

The high pressures used in injection molding can cause a "crazing" effect at the thinned briding material extending over the gap defined by the groove. This crazed zone is rendered more visible as the part is removed from the mold, particularly if the part is not completely cooled when it is being removed.

The net effect is that the molded groove becomes visible on the exterior side.

It is difficult to accurately and reliably control the depth of mechanical cutting of component materials such as sheet vinyl, since the material is variably compressed by the pressure of a cutting instrument.

U. S. Patent No. 5,082,310, referenced above, describes a partial cutting procedure which is intended to enable accurate control over the depth of cut into a sheet of pliant plastic material such as a vinyl skin. How-

ever, a purely mechanical cutting operation still has other inherent accuracy limitations and is slow to execute.

Also, some cover materials have irregular inside surfaces, i.e., dry powder slush processes create such irregularities. If the groove depth were constant, this results in an irregular thickness of the remaining material. This leads to erratic performance as the resistance to opening pressure will vary greatly.

The groove width is also important, in that if a too narrow groove is cut into many plastics, a "self healing" may occur, particularly at elevated temperatures in which the groove sides will re-adhere to each other, causing the preweakening effect to be erratic or neutralized.

The required groove width also varies with the notch sensitivity of the material being preweakened.

A further difficulty is encountered in assembling the preweakened component to the interior trim structure so that the lines of preweakening are properly registered with the other components. For example, the vinyl skin in a skin and foam instrument panel must be accurately positioned on the instrument panel substrate and the deployment door substrate panels so that the preweakening lines are stressed as the door edges hinge out under pressure from the air bag.

This alignment requirement creates manufacturing difficulties and increased costs particularly since a variety of forms of instrument panel structures are employed, i.e., skin and foam, vinyl clad, hard plastic with a finished surface, etc., since a variety of forming techniques are employed, i.e., vacuum formed calendered plastic sheet, dry powder slush molded, injection molded, etc. A leather covering layer is sometimes may be used in lieu of a vinyl plastic covering layer.

Accordingly, it is an object of the present invention to provide a process for preweakening trim components overlying an air bag installation by groove scoring which is highly accurate in production implementation, and which may be efficiently integrated into the trim piece manufacture to lower costs and improve results.

Summary of the Invention

According to the invention, the preweakening groove scoring of a smoothly contoured trim piece cover material overlying an air bag receptacle is carried out by the use of a laser beam which is controlled and guided so as to produce grooves of a precise depth and width formed by the laser beam energy into the undersurface of various trim piece cover materials such as a vacuum formed sheet of vinyl.

A sensor provides a feedback signal allowing relative positioning of the workpiece and/or varying of the laser beam source intensity or to precisely control the groove depth to achieve a constant thickness of the remaining material.

The workpiece and laser beam source can be mounted for relative movement in a two-axis positioner table, or alternatively, a system of movable reflectors can optically generate the groove pattern.

A five axis robotic arm can also be used to guide the laser beam source in the required pattern extending in three dimensions, and in process or post-process gaging can also be utilized to correct the laser and robot control and improve results.

The laser beam preweakening groove scoring can be carried out on the cover piece prior to its incorporation into the trim piece or such groove scoring can be carried out after attachment to a substrate or other trim elements grooving the underlying substrate and partially scoring the cover layer at the same time to create a deployment door substrate panel while preweakening the cover material.

The laser beam apparatus can further be utilized to trim the assembled trim piece.

Description of the Drawings

Figure 1 is a perspective diagrammatic view of a laser beam scoring apparatus having a trim piece disposed therein being preweakened in a predetermined pattern by laser beam groove scoring.

Figure 2 is a fragmentary view of a trim piece having a preweakening groove formed therein back filled with a filler material.

Figure 3 is a perspective diagrammatic view of another form of the laser beam scoring apparatus according to the invention and having a trim piece disposed therein being preweakened in a predetermined pattern by laser beam groove scoring.

Figure 4 is a perspective, simplified representation of a preferred robot arm form of the laser beam scoring and cutting apparatus together having a trim piece disposed therein being trimmed and preweakened in a predetermined pattern by laser beam groove scoring.

Figure 4A is a perspective, simplified view of the robot arm laser beam scoring and cutting apparatus of Figure 4 with an added robot arm for in-process gaging of the trim piece surface.

Figure 5 is an enlarged, fragmentary sectional view taken through a dry powder slush molded cover and along a preweakening laser scored groove.

Figure 5A is a sectional view of the cover of Figure 5 taken across the preweakening groove.

Figure 6 is an enlarged, fragmentary sectional view taken through smooth calendered sheet stock, vacuum formed into an air bag installation cover layer, laser scored from the undersurface.

Figure 7 is a front perspective view of a steering wheel cover which overlies an air bag installation and which has been preweakened in a predetermined pattern with a laser scored grooving.

Figure 8 is an enlarged sectional view of a portion of the steering wheel cover shown in Figure 7, the section taken across the laser formed groove.

Figure 9 is an enlarged sectional view of a vinyl cladding cover material which has been laser scored with grooves of various depths.

Figure 10 is an enlarged sectional view of a layer of vinyl a vacuum formed to a thermoplastic substrate such as for an instrument panel trim piece.

Figure 11 is an enlarged sectional view of a leather covering material which has been pretreated and subsequently laser scored through the pretreated region.

Figure 12 is an enlarged sectional view of the leather covering material which has been laser scored without the pretreatment in the region of the scoring.

Figure 13 is an enlarged sectional view of a cosmetic covering such as a fabric material having a backing layer, preweakened by being laser scored to penetrate the backing layer.

Figure 14 is an enlarged sectional view of a composite cover comprised of a metal substrate panel with an overlying skin, both preweakened by a laser-formed groove.

Figure 15 is an enlarged sectional view of molded urethan with a molded-in-place scrim, both preweakened with a laser formed groove.

Figure 16 is a fragmentary section of a trim piece workpiece in which the substrate is being cut at the same time the covering layer is being scored.

Figure 17 is a sectional view of a trim piece being preweakened by being perforated with an intermittently generated laser beam.

Figure 18 is a sectional view of a trim piece being scored to variable depths with a pulsating laser beam.

Figure 19 is a fragmentary plan view of a laser scored groove with transverse slits added to establish local weakening to control the site at which tearing is initiated.

Detailed Description

In the following detailed description, certain specific terminology will be employed for the sake of clarity, but it is to be understood that the same is not intended to be limiting and should not be so construed inasmuch as the invention is capable of taking many forms and variations within the scope of the appended claims.

The present invention is concerned with preweakening of an automotive interior trim piece such as a steering wheel cover or an instrument panel overlying an air bag receptacle stored behind the trim piece. The surface of the interior trim presented to the passenger compartment must be aesthetically pleasing rather than starkly utilitarian. There has also been developed a preference for eliminating any suggestion of the presence of the stored air bag. In the past, separately defined deployment doors have been fit into an opening in the instrument panel. In the case of a wheel cover, visible delineations segmenting the cover to form deployment doors have been provided.

Internal grooves have also been provided, typically molded into the trim piece itself.

As described above, molded grooves have sometimes resulted in exteriorly visible "witness" lines, since the high injection pressures forcing the plastic through the narrow gap remaining above the groove has resulted in a crazing pattern, as well as slight cracking when the part is removed from the mold.

The present invention comprises the process of laser scoring to obtain the preweakening internal groove after the cover has been molded or otherwise formed.

A laser beam is directed at the cover layer or other trim piece component to score the component along a path defining the desired pattern matching the deployment doors.

The laser scoring has been found to result in elimination of any exteriorly visible lines, even where minimum material remains above the scoring groove.

Referring to a first embodiment of a laser scoring apparatus 10 suitable for practice of the invention, a small (25-150 watt) carbon dioxide gas laser source 12 producing a coherent infrared laser output beam 14 at 10.6 micron wavelength is driven to effect controlled scoring of a region of a polymer sheet material instrument panel cover 16 extending over an air bag installation when installed. The cover 16 is moved relative the laser source 12 to cause tracing of a particular pattern at a precise rate of scoring by a multiaxis positioning system 17. The laser output beam 14 is focussed to a spot or small diameter pencil beam using one or more focussing elements 18 to cause formation of a score line 20 of acceptable width. The presence of the score line 20 which is cut to a significant depth generates a seam which is invisible when viewed from outside face 21 of cover 16. The outside face 21 of cover 16 forms the cosmetic surface presented to occupants of the vehicle.

The width of the score line 20 is generally minimized in typical applications but self healing may be avoided when necessary by making wider cuts which may be backfilled with a material having physical properties having generally beneficial physical properties for improving bursting of the invisible seam during air bag operation in the vehicle.

For example and referring to Figure 2, a portion of a polymer sheet instrument panel cover 16 with a wide score line 22 and with filler 24 comprising a cured in place silicone rubber bead is shown. Filler 24 provides mechanical support in a similar fashion as was experienced before polymer was removed by the laser. The mechanical support provided by filler 24 prevents deterioration of cover 16 over the lifetime of the vehicle.

Typical focusing elements for infrared laser 12 comprise gallium arsenide or germanium refractive lens members, or gold reflective members. Several alternate laser types will achieve good results and laser source 12 may be an excimer, solid state, argon gas, or diode laser. However, the carbon dioxide laser is likely to be the least expensive in both initial cost and over the required lifetime.

If laser source 12 produces continuous output, the depth of the score line 20 is controlled by the laser output power density at the surface of cover 16 and the rate at which cover 16 moves relative the beam 14.

In another process, laser source 12 may be controlled to generate pulses of a laser output beam, each pulse removing by heat ablation or combustion a minute quantity of cover 16 material. Depth is therefore controlled by applying a particular number of pulses before moving to an adjacent, possibly overlapping, site on the inside of cover 16. The pulsed laser technique combined with a stepwise movement of cover 16 should result in superior control over the process when a computer based controller 26 is used.

Multiaxis positioning system 17 may be driven by a multiplicity of electric motors controlled by a small computerized controller 26 as shown, or alternatively, by electromechanical actuation of a multiplicity of cams and mechanical devices which move the cover 16 in a proper pattern at appropriately controlled rates.

In most industrial applications, the focusing elements 18 must be maintained clean and free of blowback debris emanating from the score line 20. A free flowing gas system 28 is frequently employed to achieve focusing element 18 cleanliness. Also, certain gases, if directed to the score line 20 formed at the laser impingement area, will alter the chemistry and thermodynamics at the scoring site. For example, inert gases such as nitrogen or argon can displace the oxygen in the air at the impingement site and prevent both charring and local combustion while keeping the focusing elements clean. Alternate gases and flow rates can dramatically alter the properties of the resulting score line 20 and create a wide range of physical properties of the cover 16.

Figure 3 shows yet another embodiment in which the cover 16 is maintained in a fixed position and the laser output beam 14A is manipulated by a system of controlled positioning translating mirrors 30 and a controlled positioning focusing system 32.

Figure 4 illustrates a preferred form of the invention, in which a self-contained laser generator 34 is mounted to a robot arm manipulator 36, which moves the laser generator 34 under program control stored in a central computer control 38 and directing a robot controller 40, so as to cause a focused laser beam 14B to trace a pattern on a trim piece cover 42 corresponding to a programmed score line.

The computer controller 38 may also be connected to a laser controller 44 which can vary the operation and power level of the laser generator 34.

The cover 42 is fixtured on an ultrasonic sensor 46 which generates signals corresponding to the thickness of material remaining after the groove scoring is produced by the laser beam 14B such as to provide a feedback signal to the central computer control 38 to vary the position of the laser generator 34 and/or its power output to precisely control the thickness of material remaining after the groove scoring is produced. The resistance to tearing of the remaining material above the groove is important to proper air bag deployment and hence its thickness should be controlled.

Such ultrasonic sensors capable of gaging internal features, such as material thickness, are commercially available, and hence details are not here given.

The laser generator 34 is preferably of the "diffusion cooled" type which does not require gas line hookups and thus is readily mountable to a robot arm manipulator. Accordingly, the optical system is simplified as the beam is directed by robot arm motion, lower costs and improving performance. A more rugged, reliable installation also results, suited to a production environment.

Diamond™ lasers available from Convergent Energy of Sturbridge, Massachusetts are perfectly suited for this application.

Figure 4A shows a variation wherein a second robot arm 36A is provided which manipulates a gaging laser beam generator 48, directing a reflected low power laser beam 52 at the cover 16, which is detected and analyzed in a laser gaging circuit 50. From this, there is developed a signal in the laser gaging circuit 50 indicating the precise location of the cover surface at a point just ahead of the cutting laser 14B. This allows the central computer control 38 to cause the position of the cutting laser beam generator 34 to be shifted by the robot arm 36 correspondingly (or to adjust the output beam) so as to maintain a constant groove depth.

The laser beam can be directed to not only produce the scoring of the cover 42, but may produce cutout openings 54 therein. Further, the perimeter of a substrate panel 56 to which the cover 42 is assembled can be trimmed as well, achieving significant manufacturing economies.

Figures 5 and 5A illustrate the application of the above-described process to a cover panel 58 formed by a dry powder slush molding operation. This process is commercially practiced by depositing a powder on a heated mold surface, which results in a smooth outer surface 60, grained and painted, which is exposed within the passenger compartment. The other surface 62 is relatively rough, and hence a relatively varying depth groove 64 is necessary to leave a constant thickness t of a remaining material. The thickness t must be controlled to achieve a predictable tearing strength and to avoid any visible indication on the outer surface 60.

Thus, gaging of the thickness t, as with an ultrasonic gage, is necessary, varying the depth of the groove 64 to maintain the thickness t.

Figure 6 shows a segment of a cover 66 vacuum formed from smooth calendered sheet vinyl. In this case, the groove 68 may be of constant depth inasmuch as both surfaces are smooth and the combined depths t_1 and t_2 of the groove 68 and the remaining material should be constant.

In both examples, the covers 60, 66 are assembled in a mold after scoring with an instrument panel substrate (not shown), foam injected into an intervening space to bond together the substrate and cover, as well as deployment door panels and frame, into a unitary trim piece.

Figures 7 and 8 illustrate the process applied to an injection molded wheel cover 70, having an air bag

receptacle indicated in phantom at 72, aligned with a preweakening pattern 74 arranged beneath the main outer surface 76, which may be grained and painted, as indicated.

The preweakening pattern consists of a series of laser scored grooves 78 in the inner or rear face 80.

The width w of the groove is sufficient to avoid self healing. The thickness t_L of the laser beam scored groove 78 may be less than the remaining thickness t_M of a molded groove and still remain invisible from the finished surface 76.

It is also noted that the laser scoring process can be carried out very rapidly, and saves processing time over the molding time where a long cooling interval is required to avoid cracking over the thinned out region above the preweakening groove.

The scoring depth can vary from 20%-80% of the total thickness depending on the available tearing force, the strength of the material used, and whether or not other assisting devices are employed.

Figures 9 and 10 show the application of the process of vinyl cladding covers. In Figure 9, an outer vinyl layer 102 is bonded to a polypropylene foam backing layer 106 to form a composite cover. Laser scored grooves 104 extend into the rear face to various exemplary depths, i.e., partially into layer 106, completely through the layer 106, or partially through the covering layer 102. The groove depth required depends on the needs of the particular application, i.e., the level of force designed to cause rupture of the preweakened seam.

In Figure 10, the vinyl cladding layer 102 and backing layer 106 are vacuum formed and adhesively bonded to a thermoplastic substrate 108. In this case, the laser scored grooves 110 also penetrate the substrate 108.

Figures 11 and 12 illustrate the process applied to a leather cover 82. In Figure 11, a groove 84 is laser scored into a zone 86 which has been pretreated with lacquer to be more notch sensitive as described in detail in copending U. S. application Serial No. 08/109,122, filed August 13, 1993.

In Figure 12, a groove 88 is laser scored into an untreated leather cover 90.

Figure 13 illustrates the process applied to a cosmetic cover layer 92, shown as a textile material as might be used with a side impact air bag system, which has a scrim backing layer 94 bonded thereto.

The laser scored groove 96 penetrates completely through the backing scrim 94 and partially through the textile layer 92.

Figures 14 and 15 show applications to miscellaneous composites.

In Figure 14, a cosmetic skin 96, such as a vacuum formed vinyl sheet, is applied over a metal substrate 98 (such as aluminum or steel). In this instance, the laser scoring forms a groove 100 completely penetrating the metal substrate 98 and partially penetrating the cover skin layer 96 to create the preweakening.

Figure 15 shows a skin 96A over scrim backing 98A, penetrated with the laser scored groove 100A.

Referring to Figure 16, a laser generator 112 can direct a laser beam 114 at the reverse side of a substrate panel 116 underlying a cover layer 118 and intervening foam layer 120 provided in a skin and foam construction.

The power of the laser beam 114 can be controllably varied so as to completely penetrate the substrate panel 116 and foam layer 120, but only partially penetrate the inside of the cover 118, as indicated, creating the preweakening by a laser scoring.

A deployment door panel 122 is thus formed at the same time, perfectly aligned with the preweakening pattern of the cover 118.

The use of a laser beam enables preweakening by other forms than a straight groove.

As shown in Figure 17, a series of round perforations 124 or slots 126 are formed in the cover 128 by intermittent operation of the laser generator.

Figure 18 shows a stepped, variable depth groove 130 formed in a cover 132 which varies in depth along its length. This shape may be produced by pulsating operation of the laser generator, resulting in a cyclically varying intensity laser beam.

Figure 19 shows a localized preweakening of a cover 143 having laser scored preweakening groove 136 formed therein. A series of crossing grooves are formed across the groove 136 at a selected locale. This creates a preferential intermediate point at which severing will proceed in opposite directions as indicated.

The preweakening process is readily applicable to all conventional types of trim piece construction, i.e., skin and foam with both vinyl and leather skins (vacuum formed, dry powder, molded, injection molded) vinyl clad, or hard plastic with a surface finish.

Claims

1. A process for preweakening a cover of an automotive interior trim piece in an air bag deployment opening pattern, said cover defining a smooth, uninterrupted layer overlying an air bag deployment opening, comprising the steps of:

   directing a laser beam of a predetermined intensity at an inside surface of said cover and moving said laser beam over said inside surface in said deployment opening pattern, and controlling said laser beam to score said cover along said deployment opening pattern.

2. The process according to claim 1 wherein said laser beam is operated continuously at an intensity sufficient to form a continuous groove in said cover inside surface.

3. The process according to claim 2 further including the steps of sensing the precise location of each portion of said cover inside surface prior to directing said laser beam at said portion and adjusting the impingement of said laser beam thereon in correspondence to send variations in the locations of said

cover inside surface portions to produce a constant depth groove.

4. The process according to claim 2 further including the step of sensing the thickness of cover material left after forming said groove to vary the laser beam cutting so as to maintain a constant thickness of cover material above said groove.

5. The process according to claim 1 further including the steps of first assembling said cover inside surface onto a substrate panel included in said trim piece, and wherein said laser beam is directed at said substrate to completely penetrate the same in said pattern and scoring said cover from said inside surface.

6. The process according to claim 1 further including the step of completely severing a portion of said cover layer by directing a laser beam at said cover and relatively moving said laser beam to sever said portion therefrom.

7. The process according to claim 1 further including the step of assembling said cover to a substrate to form said trim piece, and further including the steps of trimming said substrate with said laser beam.

8. The process according to claim 2 further including the step of back filling said groove with a diverse material.

9. The process according to claim 2 wherein said laser beam is of constant intensity and said laser beam is moved at a rate to form a constant depth groove.

10. The process according to claim 1 wherein said laser beam intensity is varied and is moved at a controlled rate to create a controlled depth and width of said preweakening scoring.

11. The process according to claim 1 wherein said laser beam is pulsed to create a scoring comprised of a groove of a varying depth.

12. The process according to claim 1 wherein said laser beam is operated intermittently to create a scoring comprised of a series of through holes in said cover.

13. The process according to claim 1 further including the step of mounting a first laser generator to a first robot arm and mounting said robot arm to direct a laser beam from said first generator at said cover along a path such as to score said cover in said pattern.

14. The process according to claim 13 further including gaging said cover arm with a gaging laser beam by moving a second laser generator with a second robot arm so as to impinge portions of said cover along a path just ahead of the partial scoring of said cover, generating gaging signals corresponding to any surface variance of said cover portions, and adjusting the scoring action produced by said first laser beam generator in correspondence therewith so as to maintain a substantially constant partial scoring depth into said cover.

15. The process according to claim 14 wherein the speed of movement of said first laser beam generator is varied in accordance with said gaging signals.

16. The process according to claim 1 wherein said cover is formed from a dry powder slush having a rough surface on one side, said scoring comprised of a varying depth groove formed with said laser beam into said rough surface.

17. The process according to claim 1 wherein said trim piece comprises a molded plastic steering wheel cover and in said scoring steps a groove is formed by said laser beam.

18. The process according to claim 2 further including the step of scoring said cover material with said laser beam in a transverse direction with respect to said groove to produce localized preweakening at a selected point along said groove.

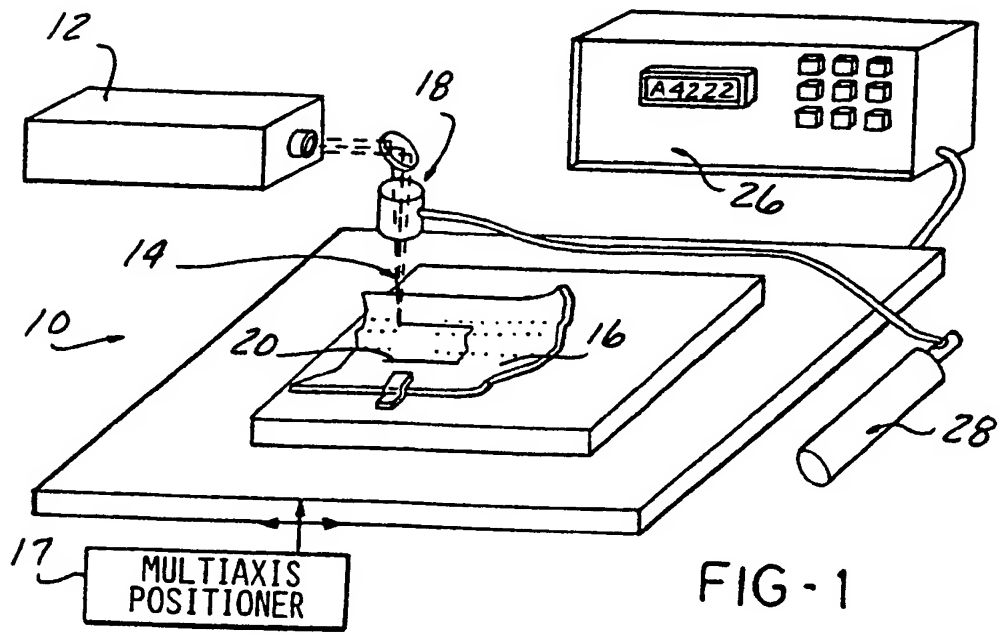


FIG - 1

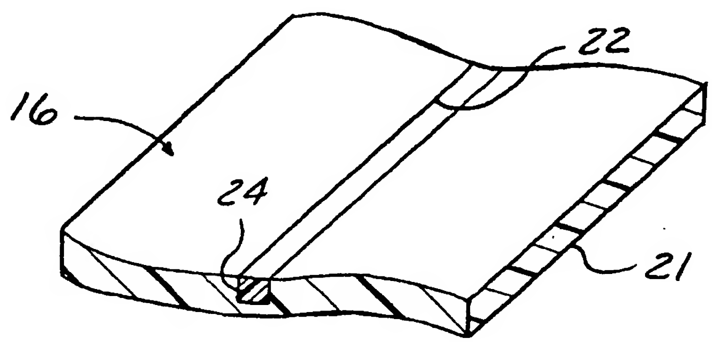
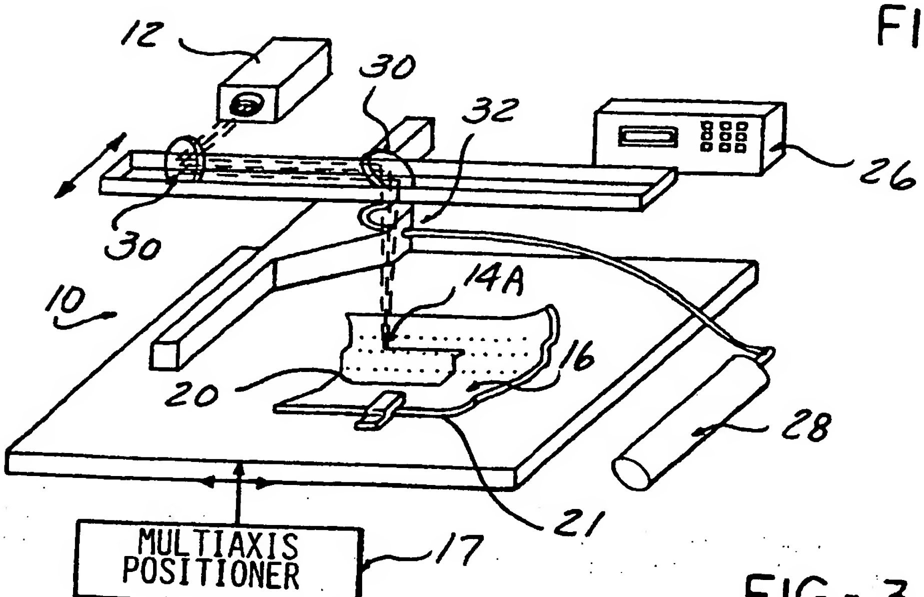


FIG - 2



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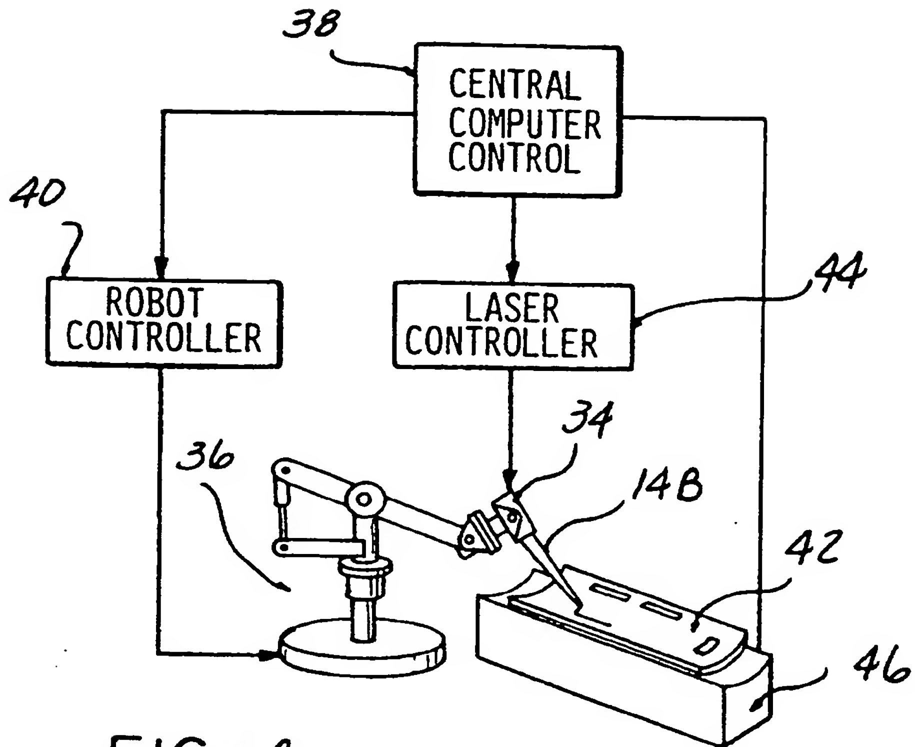
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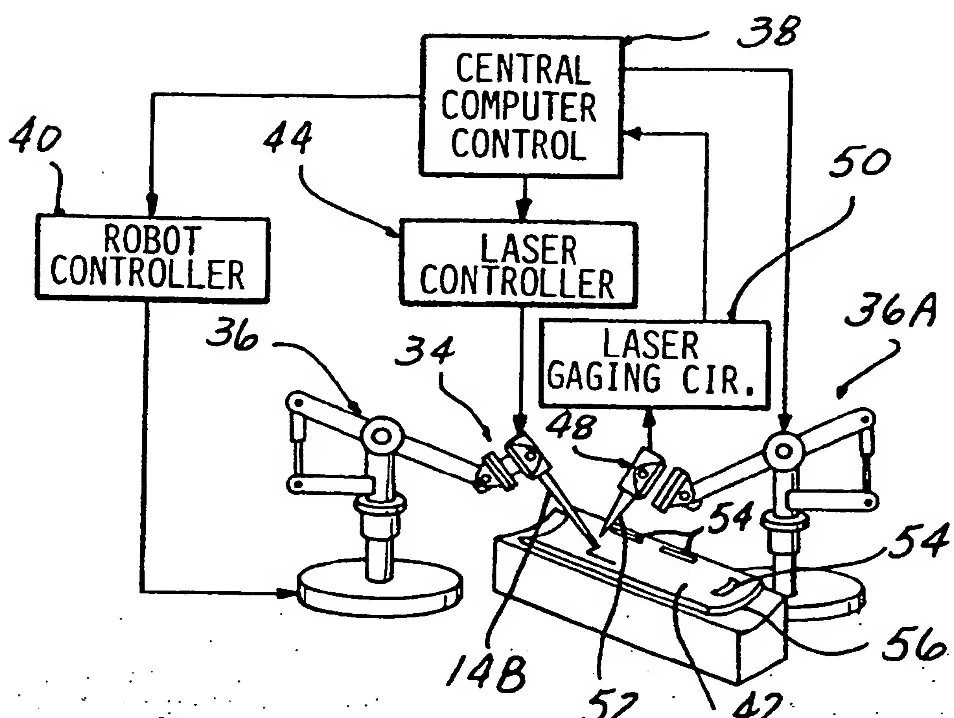
CENTRAL COMPUTER CONTROL
40
ROBOT CONTROLLER
LASER CONTROLLER
44
34
36
14B
42
46

FIG-4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ROBOT CONTROLLER
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LASER GAGING CIR.
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42

FIG-4A

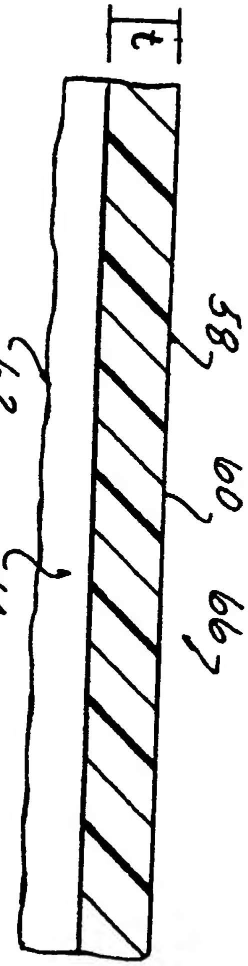

FIG-5

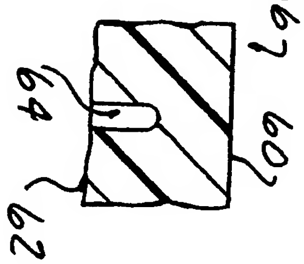

FIG-5A

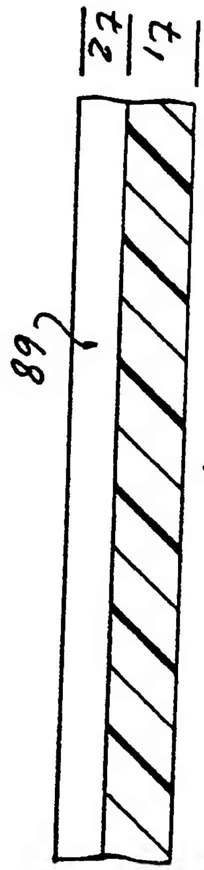

FIG-6

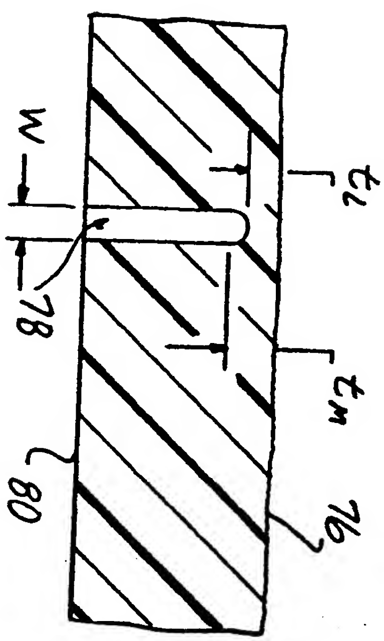

FIG-8

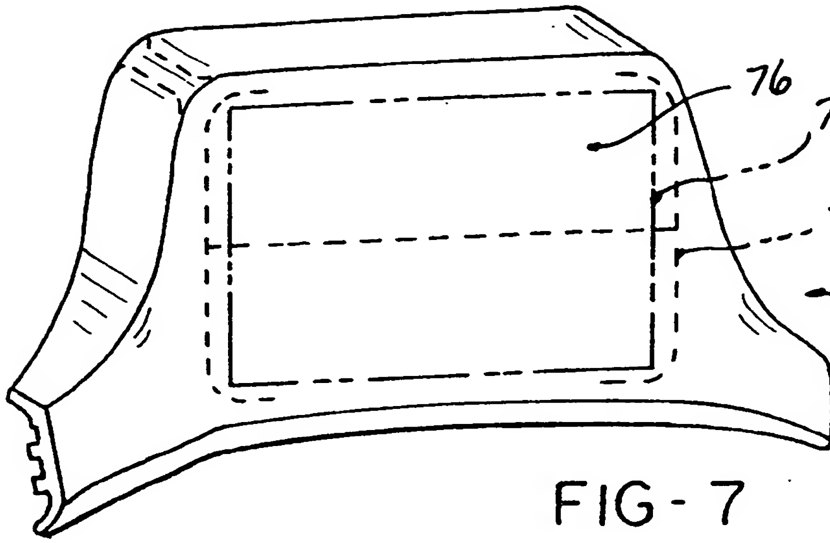

FIG-7

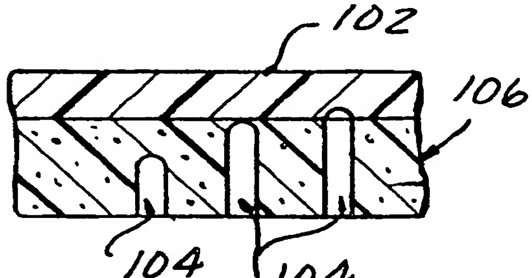

FIG-9

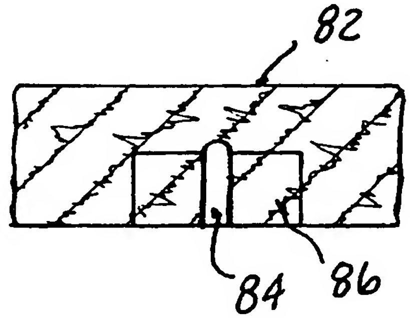

FIG-11

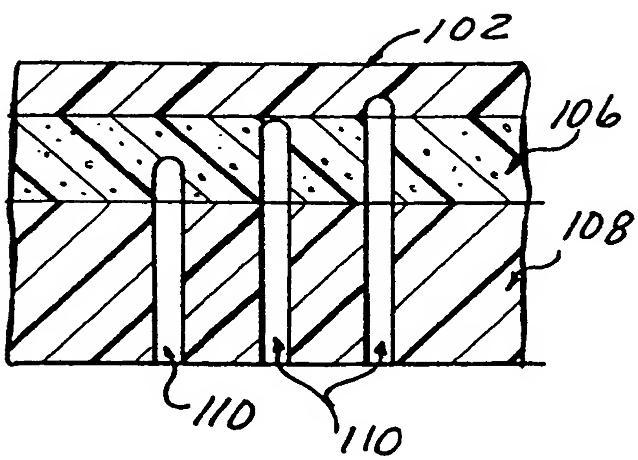

FIG-10

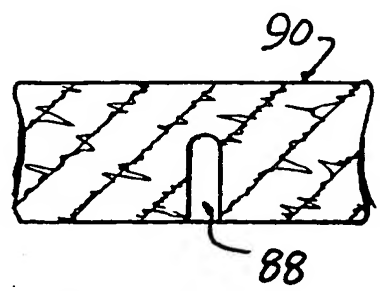

FIG-12

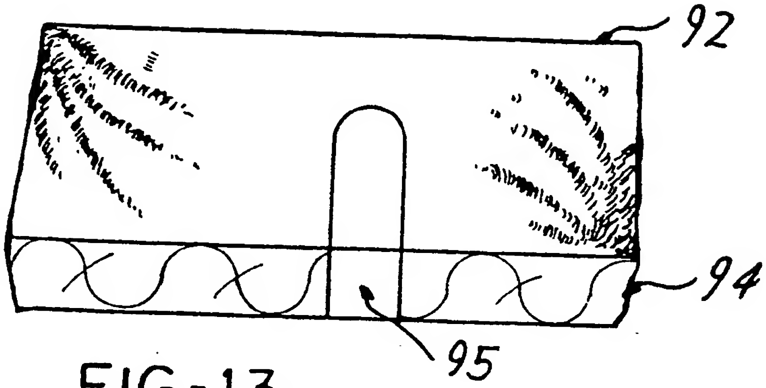

FIG-13

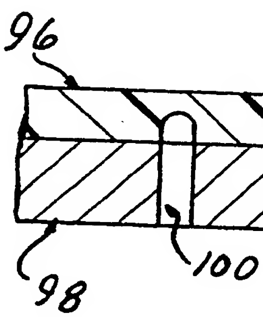

FIG-14

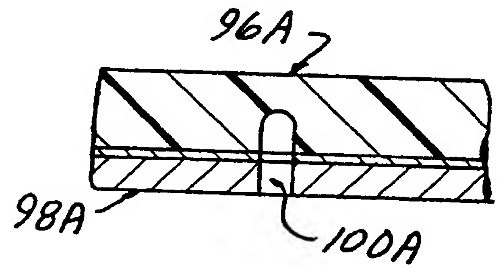

FIG-15

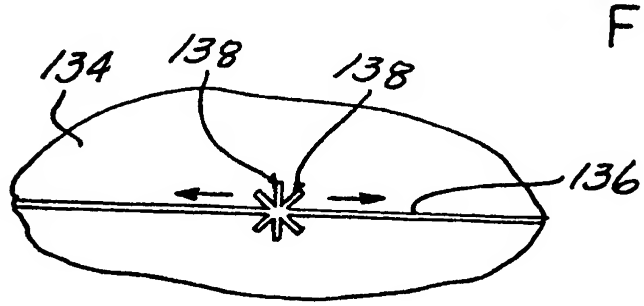

FIG-19

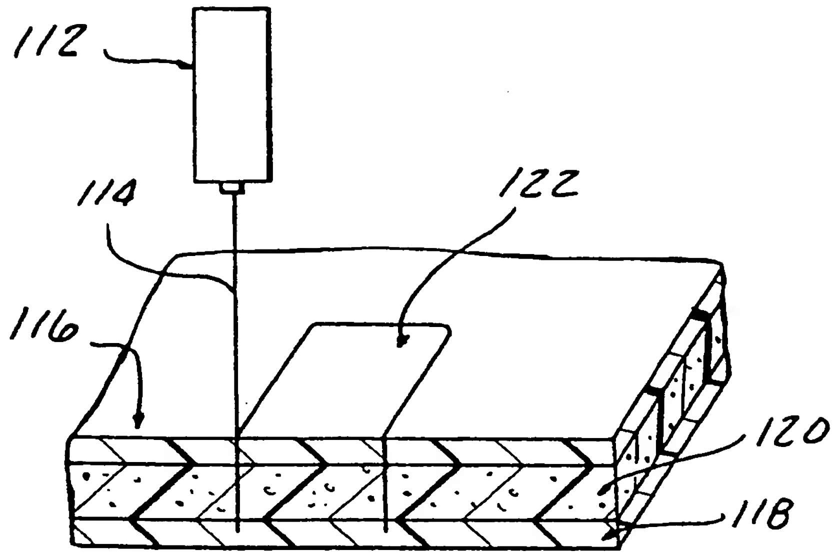

FIG-16

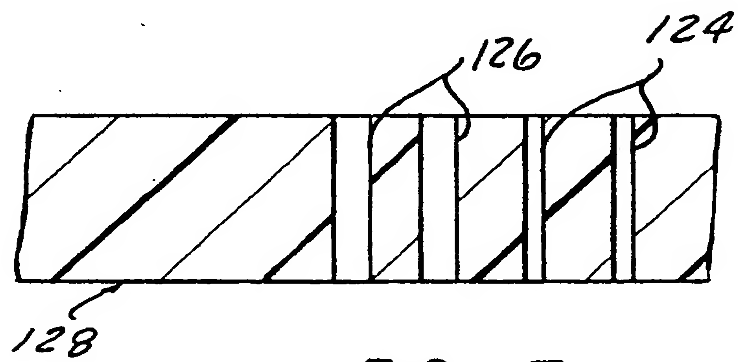

FIG-17

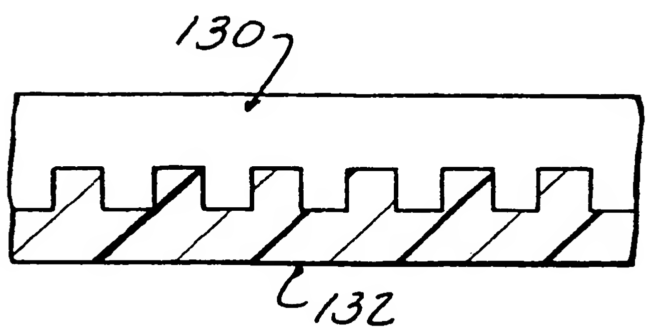

FIG-18

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(11) EP 0 711 627 A3

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DE FR GB IT

(30) Priority: 31.10.1994 US 332565

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(54) Process for preweakening an automotive trim cover for an air bag deployment opening

(57) A process for preweakening the inside of an automotive trim piece cover layer 16 of various constructions by use of a laser beam 14 so as to enable formation of an air bag deployment opening in the trim piece formed at the time the air bag deploys. The laser beam 14 impinges the inside surface of the cover 16 to form a groove scoring 20 or spaced perforations to form a preweakening pattern. A robot arm may be used to move a laser generator so as to form the preweakening pattern. The laser beam 14 can be controlled in accordance with sensed conditions to achieve accurate preweakening, and may also be used to trim substrate panels and to perform other cutting operations.

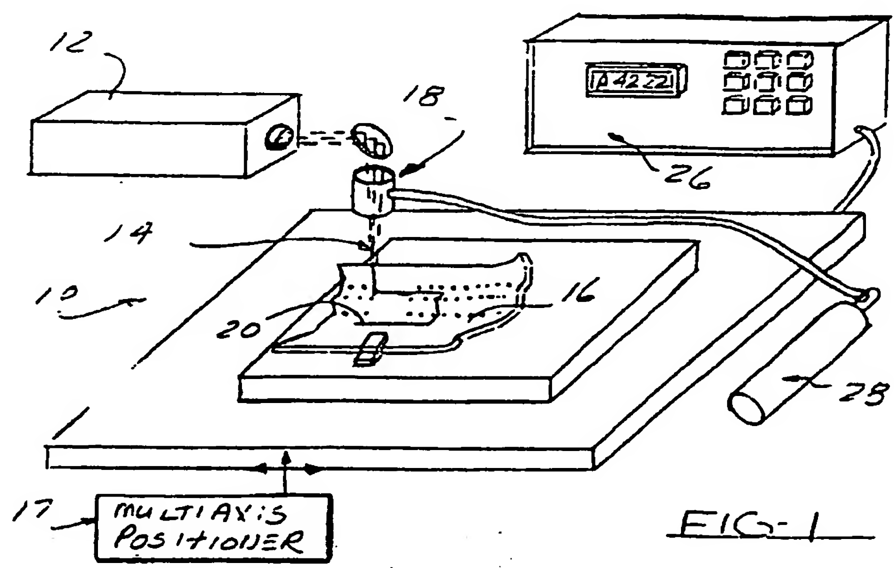

FIG-1

EP 0 711 627 A3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 95 30 2029

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	GB-A-2 276 354 (AUTOLIV KLIPPAN S.N.C.) * the whole document * ---	1,4-7,9,17	B23K26/00 B60R21/20 B23K26/02
A,D	US-A-5 082 310 (TIP ENGINEERING GROUP, INC.) * the whole document * ---	1-18	
A	EP-A-0 552 616 (MAHO AKTIENGESELLSCHAFT) * column 3, line 9 - line 22; figures 1-3 * * column 5, line 37 - line 42 * ---	1-3,10	
A	EP-A-0 280 739 (FANUC LTD) * the whole document * ---	1,13	
A	US-A-3 700 850 (WESTERN ELECTRIC COMPANY, INCORPORATED) * the whole document * -----	1,3,11	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			B23K B60R

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	10 May 1996	Aran, D

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons
& : member of the same patent family, corresponding document

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(11) EP 0 711 627 B1

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(21) Application number: 95302029.4

(22) Date of filing: 27.03.1995

(54) Process for preweakening an automotive trim cover for an air bag deployment opening

Verfahren zur Herstellung einer Solle-Brechstelle an einem Kraftfahrzeug-Verschlussdeckel für eine Luftsack-Entfaltungsöffnung

Procédé de création d'une amorce de rupture sur une garniture de recouvrement pour véhicule automobile, pour une ouverture de déploiement de sac gonflable

(84) Designated Contracting States: DE FR GB IT

(30) Priority: 31.10.1994 US 332565

(43) Date of publication of application: 15.05.1996 Bulletin 1996/20

(60) Divisional application: 99115640.7 / 0 963 806

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(56) References cited:
EP-A- 0 280 739
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US-A- 5 082 310
EP-A- 0 552 616
US-A- 3 700 850

Description

Field of the Invention

[0001] The present invention concerns cutting and scoring of covers for automotive trim pieces enclosing air bag safety devices.

Background of the Invention

[0002] Air bag safety systems have come into widespread use in automotive vehicles and light trucks and have been proposed for use in passenger trains and airplanes.

[0003] Such systems comprise an inflatable cushion, commonly referred to as an "air bag" which is stored folded in a storage receptacle and then very rapidly inflated, as with gas from a pyrotechnic gas generator, when a collision of the vehicle is detected by sensors. The air bag is thereby deployed in a position to absorb the impact of the driver or a passenger.

[0004] It is necessary that the folded air bag be stored in an enclosed secure environment within the passenger compartment, protected from tampering, and yet be allowed to properly deploy into the passenger compartment as the air bag is inflated.

[0005] It is critical that the air bag deploy within milliseconds of activation of the system in order to protect the occupant.

[0006] As noted, the air bag is enclosed within a storage receptacle, which is typically mounted behind an interior trim piece, such as a steering wheel cover in the case of the driver's side air bag, or a section of the instrument panel, in the case of the passenger's side air bag. It has been proposed to also provide side impact air bags in the vehicle doors.

[0007] One or more air bag deployment doors normally overlie the air bag receptacle and are forced open when the air bag is inflated to allow deployment of the air bag through the opening created by the door panel movement.

[0008] As described in US-A-5,082,310 issued on January 21, 1992 for an "Arrangement for Providing an Air Bag Deployment Opening", a seamless construction is advantageous in which the deployment door panels are not separately delineated within the expanse of the trim piece, but rather a smooth uninterrupted surface is provided extending over the deployment door substrate panels.

[0009] This construction necessitates severing portions of the covering of the trim piece in order to allow the door panels to hinge open.

[0010] Severing has been achieved by the pressure of the inflating air bag, or by various other methods which have been proposed, such as linear energy devices described in copending U. S. patent application Serial No. 08/279,225, filed July 22, 1994, attorney docket No. TIP-161. See also U. S. patent application Serial No. 08/027,114, filed March 4, 1993, US-A-5,127,244 and US-A-4,991,878 describing pyrotechnic elements used to cut the outer cover layer of the trim piece.

[0011] Cutter blades have also been proposed which are forced outwardly by the air bag inflation to assist in cutting the cover layer, but these outwardly swinging elements can present a potential hazard to a vehicle occupant seated in front of the deployment door.

[0012] Automotive interior trim covering materials such as vinyl plastic are relatively tough and difficult to sever, and also a predetermined severing pattern is necessary for proper door panel opening, such that heretofore preweakening grooves have been formed in the trim cover in a predetermined pattern to insure proper opening.

[0013] It has heretofore been proposed to provide an "invisible seam" installation in which the deployment door pattern is totally invisible to a person seated in the vehicle passenger compartment, and even faint outlines or "witness" lines are desirably avoided.

[0014] Scoring of the covering layer from the inside, if not done accurately, can over time become at least faintly visible from the exterior of the trim piece.

[0015] Fabrication of the automotive interior trim pieces with preweakening grooving particularly for invisible seam applications is thus a difficult manufacturing challenge.

[0016] First, the groove depth must be carefully controlled in order to achieve reliable rupture of the outer cover at exactly the right time during the air bag deployment event.

[0017] If the groove is too shallow, the thickness of the remaining material may be too great, presenting excessive resistance to severing, delaying air bag deployment. Conversely, if too little material remains, over time cracking may result, or at least allow the appearance of externally visible "witness" lines.

[0018] The preweakening effect may also be less effective if the grooves are molded-in during the process since it has been found that cutting into plastic material such as vinyl has a better preweakening effect compared to molding-in the groove during the initial manufacture of the item.

[0019] The high pressures used in injection molding can cause a "crazing" effect at the thinned briding material extending over the gap defined by the groove. This crazed zone is rendered more visible as the part is removed from the mold, particularly if the part is not completely cooled when it is being removed.

[0020] The net effect is that the molded groove becomes visible on the exterior side.

[0021] It is difficult to accurately and reliably control the depth of mechanical cutting of component materials such as sheet vinyl, since the material is variably compressed by the pressure of a cutting instrument.

[0022] US-A-5,082,310, referenced above, describes a partial cutting procedure which is intended to enable

accurate control over the depth of cut into a sheet of pliant plastic material such as a vinyl skin. However, a purely mechanical cutting operation still has other inherent accuracy limitations and is slow to execute.

[0023] Also, some cover materials have irregular inside surfaces, i.e., dry powder slush processes create such irregularities. If the groove depth were constant, this results in an irregular thickness of the remaining material. This leads to erratic performance as the resistance to opening pressure will vary greatly.

[0024] The groove width is also important, in that if a too narrow groove is cut into many plastics, a "self healing" may occur, particularly at elevated temperatures in which the groove sides will re-adhere to each other causi ng the preweakening effect to be erratic or neutralized.

[0025] The required groove width also varies with the notch sensitivity of the material being preweakened.

[0026] A further difficulty is encountered in assembling the preweakened component to the interior trim structure so that the lines of preweakening are properly registered with the other components. For example, the vinyl skin in a skin and foam instrument panel must be accurately positioned on the instrument panel substrate and the deployment door substrate panels so that the preweakening lines are stressed as the door edges hinge out under pressure from the air bag.

[0027] This alignment requirement creates manufacturing difficulties and increased costs particularly since a variety of forms of instrument panel structures are employed, i.e., skin and foam, vinyl clad, hard plastic with a finished surface, etc., since a variety of forming techniques are employed, i.e. vacuum formed calendered plastic sheet, dry powder slush molded, injection molded, etc. A leather covering layer is sometimes used in lieu of a vinyl plastic covering layer.

[0028] Accordingly, it is an object of the present invention to provide a process for preweakening trim components overlying an air bag installation by groove scoring which is highly accurate in production implementation, and which may be efficiently integrated into the trim piece manufacture to lower costs and improve results.

[0029] GB-A-2,276,354 discloses a process for preweakening an automotive interior trim piece which is used to overly an air bag installation, the air bag installation including a folded air bag adapted to be inflated and deployed upon detection of a collision, the preweakening enabling formation of an air bag deployment opening extending through the trim piece by the inflating air bag pushing through the trim piece, the trim piece having a smooth, uninterrupted cover layer overlying a substrate panel associated with an air bag deployment door, there being a foam layer therebetween, wherein a laser beam is used to score the trim piece by cutting through the substrate panel and the intervening foam layer in forming the preweakening.

[0030] According to one aspect of the present invention there is provided such a process which is characterised by the steps which are claimed in the second part of claim 1.

[0031] Preferred features of this aspect of the invention are claimed in claims 2 to 17 and 20 to 22.

[0032] According to another aspect of this invention there is provided apparatus for prescoring an inside of an automotive interior trim piece having a substrate and an overlying cover layer as claimed in claim 18.

[0033] Preferably the apparatus includes sensor means as claimed in claim 19.

[0034] In a preferred embodiment of this invention the preweakening groove scoring of a smoothly contoured trim piece cover material overlying an air bag receptacle is carried out by the use of a laser beam which is controlled and guided so as to produce grooves of a precise depth and width formed by the laser beam energy into the undersurface of various trim piece cover materials such as a vacuum formed sheet of vinyl.

[0035] A sensor provides a feedback signal allowing relative positioning of the workpiece and/or varying of the laser beam source intensity or to precisely control the groove depth to achieve a constant thickness of the remaining material.

[0036] The workpiece and laser beam source can be mounted for relative movement in a two-axis positioner table, or alternatively, a system of movable reflectors can optically generate the groove pattern.

[0037] A five axis robotic arm can also be used to guide the laser beam source in the required pattern extending in three dimensions, and in process or post-process gaging can also be utilized to correct the laser and robot control and improve results.

[0038] The laser beam preweakening groove scoring is carried out on the cover piece prior to its incorporation into the trim piece.

[0039] The laser beam apparatus can further be utilized to trim the assembled trim piece.

Description of the Drawings

[0040] Figure 1 is a perspective diagrammatic view of a laser beam scoring apparatus having a trim piece disposed therein being preweakened in a predetermined pattern by laser beam groove scoring.

[0041] Figure 2 is a fragmentary view of a trim piece having a preweakening groove formed therein back filled with a filler material.

[0042] Figure 3 is a perspective diagrammatic view of another form of the laser beam scoring apparatus which embodies the invention and having a trim piece disposed therein being preweakened in a predetermined pattern by laser beam groove scoring.

[0043] Figure 4 is a perspective, simplified representation of a preferred robot arm form of the laser beam scoring and cutting apparatus together having a trim piece disposed therein being trimmed and preweakened in a predetermined pattern by laser beam groove scoring.

[0044] Figure 4A is a perspective, simplified view of the robot arm laser beam scoring and cutting apparatus of Figure 4 with an added robot arm for in-process gagging of the trim piece surface.

[0045] Figure 5 is an enlarged, fragmentary sectional view taken through a dry powder slush molded cover and along a preweakening laser scored groove.

[0046] Figure 5A is a sectional view of the cover of Figure 5 taken across the preweakening groove.

[0047] Figure 6 is an enlarged, fragmentary sectional view taken through smooth calendered sheet stock, vacuum formed into an air bag installation cover layer, laser scored from the undersurface.

[0048] Figure 7 is a front perspective view of a steering wheel cover which overlies an air bag installation and which has been preweakened in a predetermined pattern with a laser scored grooving.

[0049] Figure 8 is an enlarged sectional view of a portion of the steering wheel cover shown in Figure 7, the section taken across the laser formed groove.

[0050] Figure 9 is an enlarged sectional view of a vinyl cladding cover material which has been laser scored with grooves of various depths.

[0051] Figure 10 is an enlarged sectional view of a layer of vinylcladding vacuum formed to a thermoplastic substrate such as for an instrument panel trim piece which has been scored with grooves of various depths.

[0052] Figure 11 is an enlarged sectional view of a leather covering material which has been pretreated and subsequently laser scored through the pretreated region.

[0053] Figure 12 is an enlarged sectional view of the leather covering material which has been laser scored without the pretreatment in the region of the scoring.

[0054] Figure 13 is an enlarged sectional view of a cosmetic covering such as a fabric material having a backing layer, preweakened by being laser scored to penetrate the backing layer.

[0055] Figure 14 is an enlarged sectional view of a composite cover comprised of a metal substrate panel with an overlying skin, both preweakened by a laser-formed groove.

[0056] Figure 15 is an enlarged sectional view of molded urethane with a molded-in-place scrim, both preweakened with a laser formed groove.

[0057] Figure 16 is a fragmentary section of a trim piece workpiece in which the substrate is being cut at the same time the covering layer is being scored.

[0058] Figure 17 is a sectional view of a trim piece being preweakened by being perforated with an intermittently generated laser beam.

[0059] Figure 18 is a sectional view of a trim piece being scored to variable depths with a pulsating laser beam.

[0060] Figure 19 is a fragmentary plan view of a laser scored groove with transverse slits added to establish local weakening to control the site at which tearing is initiated.

Detailed Description

[0061] In the following detailed description, certain specific terminology will be employed for the sake of clarity, but it is to be understood that the same is not intended to be limiting and should not be so construed inasmuch as the invention is capable of taking many forms and variations within the scope of the appended claims.

[0062] The present invention is concerned with preweakening of an automotive interior trim piece such as a steering wheel cover or an instrument panel overlying an air bag receptacle stored behind the trim piece. The surface of the interior trim presented to the passenger compartment must be aesthetically pleasing rather than starkly utilitarian. There has also been developed a preference for eliminating any suggestion of the presence of the stored air bag. In the past, separately defined deployment doors have been fitted into an opening in the instrument panel. In the case of a wheel cover, visible delineations segmenting the cover to form deployment doors have been provided.

[0063] Internal grooves have also been provided, typically molded into the trim piece itself.

[0064] As described above, molded grooves have sometimes resulted in exteriorly visible "witness" lines, since the high injection pressures forcing the plastic through the narrow gap remaining above the groove has resulted in a crazing pattern, as well as slight cracking when the part is removed from the mold.

[0065] The present invention comprises the process of laser scoring to obtain the preweakening internal groove after the cover has been molded or otherwise formed.

[0066] A laser beam is directed at the cover layer or other trim piece component to score the component along a path defining the desired pattern matching the deployment doors.

[0067] The laser scoring has been found to result in elimination of any exteriorly visible lines, even where minimum material remains above the scoring groove.

[0068] Referring to a first embodiment (see Figure 1) of a laser scoring apparatus 10 suitable for practice of the invention, a small (25-150 watt) carbon dioxide gas laser source 12 producing a coherent infrared laser output beam 14 at 10.6 micron wavelength is driven to effect controlled scoring of a region of a polymer sheet material instrument panel cover 16 extending over an air bag installation when installed. The cover 16 is moved relative the laser source 12 to cause tracing of a particular pattern at a precise rate of scoring by a multi-axis positioning system 17. The laser output beam 14 is focussed to a spot or small diameter pencil beam using one or more focussing elements 18 to cause formation of a score line 20 of acceptable width. The presence of the score line 20 which is cut to a significant depth generates a seam which is invisible when viewed from outside face 21 of cover 16 (see Figure 2). The outside face

21 of cover 16 forms the cosmetic surface presented to occupants of the vehicle.

[0069] The width of the score line 20 is generally minimized in typical applications but self healing may be avoided when necessary by making wider cuts which may be backfilled with a material having generally beneficial physical properties for improving bursting of the invisible seam during air bag operation in the vehicle.

[0070] For example and referring to Figure 2, a portion of a polymer sheet instrument panel cover 16 with a wide score line 22 and with filler 24 comprising a cured in place silicone rubber bead is shown. Filler 24 provides mechanical support in a similar fashion as was experienced before polymer was removed by the laser. The mechanical support provided by filler 24 prevents deterioration of cover 16 over the lifetime of the vehicle.

[0071] Typical focusing elements for infrared laser 12 comprise gallium arsenide or germanium refractive lens members, or gold reflective members. Several alternate laser types will achieve good results and laser source 12 may be an excimer, solid state, argon gas, or diode laser. However, the carbon dioxide laser is likely to be the least expensive in both initial cost and over the required lifetime.

[0072] If laser source 12 produces continuous output, the depth of the score line 20 is controlled by the laser output power density at the surface of cover 16 and the rate at which cover 16 moves relative the beam 14.

[0073] In another process, laser source 12 may be controlled to generate pulses of a laser output beam, each pulse removing by heat ablation or combustion a minute quantity of cover 16 material. Depth is therefore controlled by applying a particular number of pulses before moving to an adjacent, possibly overlapping, site on the inside of cover 16. The pulsed laser technique combined with a stepwise movement of cover 16 should result in superior control over the process when a computer based controller 26 is used.

[0074] Multiaxis positioning system 17 may be driven by a multiplicity of electric motors controlled by a small computerized controller 26 as shown, or alternatively, by electromechanical actuation of a multiplicity of cams and mechanical devices which move the cover 16 in a proper pattern at appropriately controlled rates.

[0075] In most industrial applications, the focusing elements 18 must be maintained clean and free of blowback debris emanating from the score line 20. A free flowing gas system 28 is frequently employed to achieve focusing element 18 cleanliness. Also, certain gases, if directed to the score line 20 formed at the laser impingement area, will alter the chemistry and thermodynamics at the scoring site. For example, inert gases such as nitrogen or argon can displace the oxygen in the air at the impingement site and prevent both charring and local combustion while keeping the focusing elements clean. Alternate gases and flow rates can dramatically alter the properties of the resulting score line 20 and create a wide range of physical properties of the cover 16.

[0076] Figure 3 shows yet another embodiment in which the cover 16 is maintained in a fixed position and the laser output beam 14A is manipulated by a system of controlled positioning translating mirrors 30 and a controlled positioning focusing system 32.

[0077] Figure 4 illustrates a preferred form of the invention, in which a self-contained laser generator 34 is mounted to a robot arm manipulator 36, which moves the laser generator 34 under program control stored in a central computer control 38 and directing a robot controller 40, so as to cause a focused laser beam 14B to trace a pattern on a trim piece cover 42 corresponding to a programmed score line.

[0078] The computer controller 38 may also be connected to a laser controller 44 which can vary the operation and power level of the laser generator 34.

[0079] The cover 42 is fixtured on an ultrasonic sensor 46 which generates signals corresponding to the thickness of material remaining after the groove scoring is produced by the laser beam 14B such as to provide a feedback signal to the central computer control 38 to vary the position of the laser generator 34 and/or its power output to precisely control the thickness of material remaining after the groove scoring is produced. The resistance to tearing of the remaining material above the groove is important to proper air bag deployment and hence its thickness should be controlled.

[0080] Such ultrasonic sensors capable of gaging internal features, such as material thickness, are commercially available, and hence details are not here given.

[0081] The laser generator 34 is preferably of the "diffusion cooled" type which does not require gas line hookups and thus is readily mountable to a robot arm manipulator. Accordingly, the optical system is simplified as the beam is directed by robot arm action, lower costs and improving performance. A more rugged, reliable installation also results, suited to a production environment.

[0082] Diamond™ lasers available from Convergent Energy of Sturbridge, Massachusetts are perfectly suited for this application.

[0083] Figure 4A shows a variation wherein a second robot arm 36A is provided which manipulates a gaging laser beam generator 48, directing a low power laser beam 52 at the cover 42 from which that beam 52 is reflected, which reflected laser beam is detected and analyzed in a laser gaging circuit 50. From this, there is developed a signal in the laser gaging circuit 50 indicating the precise location of the cover surface at a point just ahead of the cutting laser 14B. This allows the central computer control 38 to cause the position of the cutting laser beam generator 34 to be shifted by the robot arm 36 correspondingly (or to adjust the output beam) so as to maintain a groove depth which will produce a constant thickness of remaining material.

[0084] The laser beam can be directed to not only produce the scoring of the cover 42, but may produce cutout openings 54 therein. Further, the perimeter of a sub-

strate panel 56 to which the cover 42 is assembled can be trimmed as well, achieving significant manufacturing economies.

[0085] Figures 5 and 5A illustrate the application of the above-described process to a cover panel 58 formed by a dry powder slush molding operation. This process is commercially practiced by depositing a powder on a heated mold surface, which results in a smooth outer surface 60, grained and painted, which is exposed within the passenger compartment. The other surface 62 is relatively rough, and hence a relatively varying depth groove 64 is necessary to leave a constant thickness t of a remaining material. The thickness t must be controlled to achieve a predictable tearing strength and to avoid any visible indication on the outer surface 60.

[0086] Thus, gaging of the thickness t, as with an ultrasonic gage, is necessary, varying the depth of the groove 64 to maintain the thickness t.

[0087] Figure 6 shows a segment of a cover 66 vacuum formed from smooth calendered sheet vinyl. In this case, the groove 68 may be of constant depth inasmuch as both surfaces are smooth and the combined thickness t_2 of the groove 68 and t_1 of the remaining material is constant.

[0088] In both examples, the covers 58, 66 are assembled in a mold after scoring with an instrument panel substrate (not shown), foam injected into an intervening space to bond together the substrate and cover, as well as deployment door panels and frame, into a unitary trim piece.

[0089] Figures 7 and 8 illustrate the process applied to an injection molded wheel cover 70, having an air bag receptacle indicated in phantom at 72, aligned with a preweakening pattern 74 arranged beneath the main outer surface 76, which may be grained and painted, as indicated.

[0090] The preweakening pattern consists of a series of laser scored grooves 78 in the inner or rear face 80.

[0091] The width w of the groove is sufficient to avoid self healing. The thickness t_L of the material remaining above the laser beam scored groove 78 may be less than the remaining thickness t_M of a molded groove and still remain invisible from the finished surface 76.

[0092] It is also noted that the laser scoring process can be carried out very rapidly, and saves processing time over the molding time where a long cooling interval is required to avoid cracking over the thinned out region above the preweakening groove.

[0093] The scoring depth can vary from 20%-80% of the total thickness depending on the available tearing force, the strength of the material used, and whether or not other assisting devices are employed.

[0094] Figures 9 and 10 show the application of the process of vinyl cladding covers. In Figure 9, an outer vinyl layer 102 is bonded to a polypropylene foam backing layer 106 to form a composite cover. Laser scored grooves 104 extend into the rear face to various exemplary depths, i.e., partially into layer 106, completely through the layer 106, or partially through, the covering layer 102. The groove depth required depends on the needs of the particular application, i.e., the level of force designed to cause rupture of the preweakened seam.

[0095] In Figure 10, the vinyl cladding layer 102 and backing layer 106 are vacuum formed and adhesively bonded to a thermoplastic substrate 108. In this case, the laser scored grooves 110 also penetrate the substrate 108.

[0096] Figures 11 and 12 illustrate the process applied to a leather cover 82. In Figure 11, a groove 84 is laser scored into a zone 86 which has been pretreated with lacquer to be more notch sensitive as described in detail in copending U. S. application Serial No. 08/109,122, filed August 13, 1993.

[0097] In Figure 12, a groove 88 is laser scored into an untreated leather cover 90.

[0098] Figure 13 illustrates the process applied to a cosmetic cover layer 92, shown as a textile material as might be used with a side impact air bag system, which has a scrim backing layer 94 bonded thereto.

[0099] The laser scored groove 95 penetrates completely through the backing scrim 94 and partially through the textile layer 92.

[0100] Figures 14 and 15 show applications to miscellaneous composites.

[0101] In Figure 14, a cosmetic skin 96, such as a vacuum formed vinyl sheet, is applied over a metal substrate 98 (such as aluminum or steel). In this instance, the laser scoring forms a groove 100 completely penetrating the metal substrate 98 and partially penetrating the cover skin layer 96 to create the preweakening.

[0102] Figure 15 shows a skin 96A over scrim backing 98A, penetrated with the laser scored groove 100A.

[0103] Referring to Figure 16, a laser generator 112 can direct a laser beam 114 at the reverse side of a substrate panel 116 underlying a cover layer 118 and intervening foam layer 120 provided in a skin and foam construction.

[0104] The power of the laser beam 114 can be controllably varied so as to completely penetrate the substrate panel 116 and foam layer 120, but only partially penetrate the inside of the cover 118, as indicated, creating the preweakening by a laser scoring.

[0105] A deployment door panel 122 is thus formed at the sane time, perfectly aligned with the preweakening pattern of the cover 118.

[0106] The use of a laser beam enables preweakening by other forms than a straight groove.

[0107] As shown in Figure 17, a series of round perforations 124 or slots 126 are formed in the cover 128 by intermittent operation of the laser generator.

[0108] Figure 18 shows a stepped, variable depth groove 130 formed in a cover 132 which varies in depth along its length. This shape may be produced by pulsating operation of the laser generator, resulting in a cyclically varying intensity laser beam.

[0109] Figure 19 shows a localized preweakening of

a cover 134 having laser scored preweakening groove 136 formed therein. A series of crossing grooves 138 are formed across the groove 136 at a selected locale. This creates a preferential intermediate point at which severing will proceed in opposite directions as indicated.

[0110] The preweakening process is readily applicable to all conventional types of trim piece construction, i.e., skin and foam with both vinyl and leather skins (vacuum formed, dry powder, molded, injection molded) vinyl clad, or hard plastic with a surface finish.

Claims

1. A process for preweakening an automotive interior trim piece (70, 122) which is used to overlie an air bag installation (72), said air bag installation (72) including a folded air bag adapted to be inflated and deployed upon detection of a collision, said preweakening (74) enabling formation of an air bag deployment opening extending through said trim piece (70, 122) by said inflating air bag pushing through said trim piece (70, 122), said trim piece (70, 122) having a smooth, uninterrupted cover layer (58, 66, 96A, 102, 118) overlying a substrate panel (98A, 108, 116) associated with an air bag deployment door (70, 122), said cover layer (58, 66, 96A, 102, 118) and said substrate panel (98A, 108, 116) being formed separately and thereafter joined together, and a laser beam (14, 14A, 14B, 114) being used to score a portion of said trim piece (70, 122) in preweakening said trim piece (70, 122); characterised by the steps of:
scoring one side (62, 80) of said cover layer (58, 66, 96A, 102, 118) prior to joining said separately formed cover layer (58, 66, 96A, 102, 118) to said substrate panel (98A, 108, 116) by directing a laser beam (14, 14A, 14B, 114) of a predetermined intensity at said one side (62, 80) of said cover layer (58, 66, 96A, 102, 118) and moving said laser beam (14, 14A, 14B, 114) over said cover layer (58, 66, 96A, 102, 118) in a predetermined scoring pattern (74) while controlling said laser beam (14, 14A, 14B, 114) so as to produce scoring of said one side (62, 80) of said cover layer (58, 66, 96A, 102, 118) to a significant depth into said cover layer (58, 66, 96A, 102, 118).

2. A process according to claim 1, wherein said one side (62, 80) of said separate cover layer (58, 66, 96A, 102, 118) that is scored is an inside surface thereof and said cover layer (58, 66, 96A, 102, 118) is mounted to said substrate panel (98A, 108, 116) by

   assembling said scored cover layer (58, 66, 96A, 102, 118) and substrate panel (98A, 108, 116) into a mold with an intervening space therebetween, and with said scoring pattern (74) having a predetermined spatial relationship with said deployment door (70, 122); and
   filling said intervening space with plastic foam to bond said cover layer (58, 66, 96A, 102, 118) and substrate panel (98A, 108, 116) together with said foam layer (106, 120) formed therebetween and underlying said scoring pattern (74).

3. A process according to claim 2, wherein, in said scoring steps a CO_2 laser beam (14, 14A, 14B, 114) is directed at said cover layer inside surface (62, 80).

4. A process according to claim 2, further including the step of sensing the thickness (t) of said cover layer (58, 66, 96A, 102, 118) at each point along the path of the laser beam (14, 14A, 14B, 114) and varying the scoring effect produced by said laser beam (14, 14A, 14B, 114) so as to maintain a predetermined remaining thickness (t) of said cover layer (58, 66, 96A, 102, 118) along said scoring pattern (74).

5. A process according to claim 2, further including the step of completely severing a portion of said cover layer (58, 66, 96A, 102, 118) by directing a laser beam (14, 14A, 14B, 114) at said cover layer (58, 66, 96A, 102, 118) and relatively moving said laser beam (14, 14A, 14B, 114) to sever said portion therefrom.

6. A process according to claim 2, further including the step of trimming said trim piece (70, 122) with said laser beam (14, 14A, 14B, 114).

7. A process according to claim 2, further including the step of back filling with a diverse material (24) a groove (22) formed by scoring said inside surface (62, 80).

8. A process according to claim 3, wherein said CO_2 laser beam (14, 14A, 14B, 114) is of constant intensity and is moved along said pattern (74) at a rate to form a constant depth groove (68).

9. A process according to claim 3, wherein said CO_2 laser beam (14, 14A, 14B, 114) intensity is varied and is moved at a controlled rate to create a controlled depth and width of said preweakening scoring (74).

10. A process according to claim 3, wherein said CO_2 laser beam (14, 14A, 14B, 114) is varied in intensity and/or speed to create a scoring in said cover layer (58, 66, 96A, 102, 118) comprised of a groove (64) of a varying depth.

11. A process according to claim 2, wherein said laser beam (14, 14A, 14B, 114) is operated intermittently to create a scoring comprised of a series of through holes (54, 124, 126) in said cover layer (42) or said substrate panel (128).

12. A process according to claim 2, further including the step of mounting a first laser beam generator (34) to a first robot arm (36) and moving said robot arm (36) to direct said laser beam (14B) from said first generator (34) at said cover layer inside surface (62, 80) along a path such as to score said cover layer (58, 66, 96A, 102, 118) in said pattern (74).

13. A process according to claim 12, further including gaging said cover layer (58, 66, 96A, 102, 118) with a gaging laser beam (52) by moving a second laser generator (48) with a robot arm so as to impinge portions of said cover layer (58, 66, 96A, 102, 118) along a path just ahead of said scoring of said cover layer (58, 66, 96A, 102, 118), generating gaging signals corresponding to any surface variance of said cover layer portions, and adjusting the scoring produced by said laser beam generator (34) in correspondence therewith so as to maintain a substantially constant material thickness (t_1) remaining above the scoring of said cover layer (58, 66, 96A, 102, 118).

14. A process according to claim 13, wherein the speed of movement of said first laser beam generator (34) is varied in accordance with said gaging signals.

15. A process according to claim 2, wherein said cover layer (58) is formed from a dry powder slush having a rough texture on said inside surface (62), said scoring step causing a varying depth groove (64) to be formed with said laser beam (14, 14A, 14B, 114) scoring into said rough textured inside surface (22).

16. A process according to claim 2, wherein said trim piece (70, 122) comprises a molded plastic steering wheel cover (70) and in said scoring steps a groove (74) is formed by said laser beam (14, 14A, 14B, 114).

17. A process according to claim 3, further including the step of scoring said cover layer (58, 66, 96A 102, 118) with said laser beam (14, 14A, 14B, 114) in a transverse direction with respect to a groove (22) formed thereby to produce localized preweakening (74) at a selected point along said groove (22).

18. Apparatus for prescoring an inside (62, 80) of an automotive interior trim piece (70, 122) having a substrate (98A, 108, 116) and an overlying cover layer (58, 66, 96A 102, 118) comprising:

a CO_2 laser beam generator (14, 14A, 14B, 114) of sufficient power to partially penetrate said interior trim piece (70, 122); and means (10) for supporting said trim piece (70, 122) and relatively moving said supported trim piece (70, 122) and laser beam generator (34) to trace a scoring pattern (74) on said interior trim piece (70, 122) with a laser beam (14, 14A, 14B, 114) to form an air bag deployment door (70, 122) therein;

characterised by control means (38, 44 and 50) monitoring said scoring of said trim piece (70, 122) during the tracing of the scoring pattern (74) on said interior trim piece (70, 122) and varying the scoring effect of said laser beam (14, 14A, 14B, 114) to produce only a partial penetration of said interior trim piece (70, 122) by said laser beam (14, 14A, 14B, 114) at each point along the tracing of said scoring pattern (74).

19. Apparatus according to claim 18, wherein said control means (38, 44 and 50) includes sensor means for sensing the outer surface of said trim piece cover layer (58, 66, 96A, 102, 118) to vary the groove depth so as to maintain a constant thickness (t) of remaining material.

20. A process according to claim 1, wherein in said scoring steps a CO_2 laser beam (14, 14A, 14B, 114) is directed at said cover layer inside surface (62, 80).

21. A process according to claim 20, further including the step of sensing the thickness of said cover layer (58, 66, 96A, 102, 118) at each point along the path of said laser beam (14, 14A, 14B, 114) and varying the scoring effect produced by said laser beam (14, 14A, 14B, 114) so as to maintain a predetermined remaining thickness (t) of said covering skin layer (58, 66, 96A, 102, 118) along said scoring pattern (74).

22. A process according to claim 1, wherein said cover layer (58, 66, 96A, 102, 118) comprises a skin preformed with a foam backing layer (106, 120).

Revendications

1. Procédé pour la création d'une amorce d'ouverture ou d'un pré-affaiblissement d'un élément de garniture d'intérieur automobile (70,122), servant à ouvrir un système de sac gonflable (72), ce système de sac gonflable (72) comprenant un sac à air plié pouvant être gonflé et déployé lors de la détection d'une collision, ce pré-affaiblissement ou amorce de rupture (74) permettant la formation d'une ouver-

ture de déploiement d'un sac gonflable s'étendant à travers l'élément de garniture (70,122) par le sac d'air en se gonflant en poussant à travers l'élément de garniture (70,122) cet élément de garniture (70,122) présentant une couche de recouvrement lisse ininterrompue (58,66,96A,102,118) recouvrant un panneau de substrat (98A,108,116) associé à une porte de déploiement de sac gonflable (70,122), cette couche de recouvrement (58,66,96A,102,118) et le panneau de substrat (98A,108,116) étant formés séparément et sont ensuite réunis, et un faisceau ou rayon laser (14,14A, 14B,114) servant à former des pointillés sur une portion de l'élément de garniture (70,122), pour créer une amorce de rupture pour l'élément de garniture (70,122) ; caractérisé par les étapes consistant à :

former des pointillés (62,80) sur la couche de recouvrement (58,66,96A,102,118) avant de réunir la couche de recouvrement formée séparément (58,66,96A,102,118) sur le panneau de substrat (98A,108,116) en dirigeant un rayon laser (14,14A, 14B,114) d'une intensité prédéterminée sur un côté (62,80) de la couche de recouvrement (58,66,96A, 102, 118) et en déplaçant le rayon laser (14,14A, 14B,114) sur la couche de recouvrement (58,66,96A,102,118) dans une configuration de pointillés prédéterminée (74) tout en commandant le rayon laser (14,14A,14B,114) de façon à produire les pointillés sur un côté (62,80) de la couche de recouvrement (58,66,96A,102,118) à une profondeur sensible dans la couche de recouvrement (58,66,96A,102,118).

2. Procédé selon la revendication 1, dans lequel un côté (62,80) de la couche de recouvrement séparée (58,66,96A,102,118) qui est muni de pointillés, est sa surface interne et la couche de recouvrement (58,66,96A,102,118) est montée sur le panneau de substrat (98A,108,116) en

assemblant la couche de recouvrement pointillée (58,66,96A,102,118) et le panneau de substrat (98A,108,116) dans un moule avec un espace intermédiaire, et avec la configuration de pointillés (74) ayant une relation spatiale prédéterminée par rapport à la porte de déploiement (70,122) ; et

remplir l'espace intermédiaire de mousse plastique pour souder ensemble la couche de recouvrement (58,66,96A,102,118) et le panneau de substrat (98A,108,116) avec la couche de mousse (106,120) formée entre ceux-ci et située de façon sous-jacente à la configuration de pointillés (74).

3. Procédé selon la revendication 2, dans lequel dans les étapes de formation de pointillés, un rayon laser CO_2 (14,14A,14B,114) est dirigé sur la surface interne de la couche de recouvrement (62,80).

4. Procédé selon la revendication 2, comprenant de plus les étapes consistant à détecter l'épaisseur (t) de la couche de recouvrement (58,66,96A,102,118) sur chaque point le long du trajet du rayon laser (14,14A,14B,114) et à faire varier l'effet de pointillé produit par le rayon laser (14,14A,14B,114) afin de maintenir une épaisseur restante prédéterminée (t) de la couche de recouvrement (58,66,96A,102,118) le long de la configuration de pointillés (74).

5. Procédé selon la revendication 2, comprenant le plus l'étape consistant à sectionner complètement une portion de la couche de recouvrement (58,66,96A,102,118) en dirigeant un rayon laser (14,14A,14B,114) sur la couche de recouvrement (58,66,96A,102,118) et en déplaçant de façon relative le rayon laser (14,14A,14B,114) pour sectionner sa portion.

6. Procédé selon la revendication 2, comprenant de plus l'étape consistant à assurer la finition de la pièce de garniture (70,122) avec le rayon laser (14,14A,14B,114).

7. Procédé selon la revendication 2, comprenant de plus l'étape consistant à remplir avec un matériau différent (24) une gorge (22) réalisée par formation de pointillés sur la surface interne (62,80).

8. Procédé selon la revendication 3, dans lequel le rayon laser CO_2 (14,14A,14B,114) est d'intensité constante et il est déplacé le long de cette configuration (74) à une vitesse permettant de former une gorge de profondeur constante (68).

9. Procédé selon la revendication 3, dans lequel on fait varier l'intensité du rayon laser au CO_2 (14,14A, 14B,114) et on le déplace à une vitesse contrôlée pour créer une profondeur et une largeur contrôlée du pointillé d'amorce de rupture (74).

10. Procédé selon la revendication 3, dans lequel on fait varier le rayon laser au CO_2 (14,14A,14B,114) en intensité et/ou en vitesse pour créer des pointillés dans la couche de recouvrement (58,66,96A, 102,118) comprenant une gorge (64) de profondeur variable.

11. Procédé selon la revendication 2, dans lequel le rayon laser (14,14A,14B,114) est actionné par intermittence pour créer des pointillés constitués d'une série de trous traversant (54,124,126) dans la couche de recouvrement (42) ou le panneau de substrat (128).

12. Procédé selon la revendication 2, comprenant de plus l'étape consistant à monter un premier générateur de rayon laser (34) sur un premier bras de robot (36) et à déplacer le bras de robot (36) pour diriger le rayon laser (14B) à partir du premier générateur (34) au niveau de la surface interne de la couche de recouvrement (62,80), le long d'un trajet de façon à pointiller la couche de recouvrement (58,66,96A,102,118) dans cette configuration (74).

13. Procédé selon la revendication 12, comprenant de plus le calibrage de la couche de recouvrement (58,66,96A,102,118) avec un rayon laser de calibrage (52) en déplaçant un second générateur laser (48) avec un bras de robot de façon à frapper les portions de la couche de recouvrement (58,66,96A,102,118) le long d'un trajet juste devant le pointillé de la couche de recouvrement (58,66,96A,102,118) générant des signaux de calibrage correspondant à toute variation de surface des portions de la couche de recouvrement et en ajustant les pointillés produits par le générateur de rayon laser (34) de façon correspondante afin de maintenir une épaisseur de matériau sensiblement constante (t_1) restant au-dessus des pointillés de la couche de recouvrement (58,66,96A,102,118)

14. Procédé selon la revendication 13, dans lequel on fait varier la vitesse de mouvement du premier générateur de rayon laser (34) en fonction desdits signaux de calibrage.

15. Procédé selon la revendication 2, dans lequel la couche de recouvrement (58) est formée à partir d'une bouillie de poudre sèche ayant une texture rugueuse sur la surface interne (62), l'étape de création de pointillés formant une gorge de profondeur variable (64) avec le rayon laser (14,14A,14B, 114) formant des pointillés dans la surface interne de texture rugueuse (22).

16. Procédé selon la revendication 2, dans lequel l'élément de garniture (70,122) comprend un recouvrement de volant en plastique moulé (70) et dans les étapes de création de pointillés, une gorge (74) est formée par le rayon laser (14,14A,14B,114).

17. Procédé selon la revendication 3, comprenant de plus l'étape consistant à former des pointillés sur la couche de revêtement (58,66,96A,102,118) avec le rayon laser (14,14A,14B,114) dans une direction transversale à une gorge (22) ainsi formée pour produire un pré-affaiblissement ou amorce de rupture localisée (74) en un point sélectionné le long de la gorge (22).

18. Appareil pour pré-pointiller l'intérieur (62,80) d'un élément de garniture intérieur automobile (70,122) ayant un substrat (98A,108,116) et une couche de recouvrement (58,66,9A,102,118) comprenant :

un générateur de rayon laser au CO_2 (14,14A, 14B,114) de puissance suffisante pour pénétrer partiellement dans l'élément de garniture intérieure (70,122) ; et
des moyens (10) pour supporter l'élément de garniture (70,122) et déplacer de façon relative l'élément de garniture supporté (70,122) et le générateur de rayon laser (34) pour tracer une configuration de pointillés (74) sur l'élément de garniture intérieure (70,122) avec un rayon laser (14,14A,14B,114) pour y former une porte de déploiement de sac gonflable (70,122) ;

caractérisé par des moyens de commande (38,44 et 50) contrôlant la formation de pointillés sur l'élément de garniture (70,122) pendant le tracé de la configuration de pointillés (74) sur l'élément de garniture intérieure (70,122) et faire varier l'effet de pointillés du rayon laser (14,14A,14B,114) pour ne produire qu'une pénétration partielle dans l'élément de garniture intérieure (70,122) par le rayon laser (14,14A,14B,114) à chaque point le long du tracé de la configuration de pointillés (74).

19. Appareil selon la revendication 18, dans lequel les moyens de commande (38,44 et 50) comprennent des moyens de capteur pour capter la surface extérieure de la couche de recouvrement d'élément de garniture (58,66,96A,102,118) pour faire varier la profondeur de gorge de façon à maintenir une épaisseur constante (t) de matériau restant.

20. Appareil selon la revendication 1, dans lequel dans les étapes de formation de pointillés, un rayon laser au CO_2 (14,14A,14B,114) est dirigé sur la surface intérieure de la couche de recouvrement (62,80).

21. Procédé selon la revendication 20, comprenant de plus l'étape consistant à détecter l'épaisseur de la couche de recouvrement (58,66,96A,102,118) en chaque point le long du trajet du rayon laser (14,14A,14B,114) et à faire varier l'effet de pointillés produits par le rayon laser (14,14A,14B,114) afin de maintenir une épaisseur restante prédéterminée (t) de la couche membrane de recouvrement (58,66,96A,102,118) le long de la configuration de pointillés (74).

22. Procédé selon la revendication 1, dans lequel la couche de recouvrement (58,66,96A,102,118) comprend une membrane préformée avec une couche de renfort en mousse (106,120).

Patentansprüche

1. Verfahren zum Vorschwächen eines inneren Abdeckstückes (70, 122) in Kraftfahrzeugen, das verwendet wird, um über einer Airbag-Vorrichtung (72) zu liegen, wobei die Airbag-Vorrichtung (72) einen gefalteten Airbag aufweist, der adaptiert ist, um bei Nachweis eines Zusammenpralls aufgeblasen und entfaltet zu werden, wobei die Vorschwächung (74) die Bildung einer Airbag-Entfaltungsöffnung ermöglicht, die sich durch das Abdeckstück (70, 122) erstreckt, wobei der Airbag beim Aufblasen durch das Abdeckstück (70, 122) stößt, wobei das Abdeckstück (70, 122) eine glatte ununterbrochene Abdeckschicht (58, 66, 96A, 102, 118) aufweist, die über einer mit einer Airbag-Entfaltungsluke (70, 122) assoziierten Substratplatte (98A, 108, 116) liegt, wobei die Abdeckschicht (58, 66, 96A, 102, 108) und die Substratplatte (98A, 108, 116) getrennt ausgebildet und danach aneinandergefügt werden, und wobei ein Laserstrahl (14, 14A, 14B, 114) verwendet wird, um beim Abschwächen des Abdeckstückes (70, 122) Rillen in einem Abschnitt des Abdeckstückes (70, 122) zu bilden; gekennzeichnet durch die folgenden Schritte:
Bildung von Rillen auf der einen Seite (62, 80) der Abdeckschicht (58, 66, 96A, 102, 108) vor dem Aneinanderfügen der getrennt ausgebildeten Abdeckschicht (58, 66, 96A, 102, 108) an die Substratplatte (98A, 108, 116), indem ein Laserstrahl (14, 14A, 14B, 114) vorbestimmter Intensität auf die eine Seite (62, 80) der Abdeckschicht (58, 66, 96A, 102, 108) gerichtet und nach einem vorbestimmten Rillenbildungsmuster (74) über die Abdeckschicht (58, 66, 96A, 102, 108) bewegt wird, wobei der Laserstrahl (14, 14A, 14B, 114) so kontrolliert wird, daß auf der einen Seite (62, 80) der Abdeckschicht (58, 66, 96A, 102, 108) Rillen signifikanter Tiefe in die Abdeckschicht (58, 66, 96A, 102, 108) hinein erzeugt werden.

2. Verfahren nach Anspruch 1, wobei die eine Seite (62, 80) der getrennten Abdeckschicht (58, 66, 96A, 102, 108), in der die Rillenbildung stattfindet, eine innere Oberfläche davon ist, und die Abdeckschicht (58, 66, 96A, 102, 108) mit der Substratplatte (98A, 108, 116) zusammengesetzt wird durch

   Zusammensetzen der mit einer Rille versehenen Abdeckschicht (58, 66, 96A, 102, 108) und der Substratplatte (98A, 108, 116) in eine Form mit einem Zwischenraum zwischen den beiden Komponenten, wobei das Rillenbildungsmuster (74) in einer vorbestimmten räumlichen Beziehung zu der Entfaltungsluke (70, 122) steht, und

   Auffüllen des Zwischenraumes mit Kunststoffschaum, um die Abdeckschicht (58, 66, 96A, 102, 108) und die Substratplatte (98A, 108, 116) mittels der Schaumschicht (106, 120) zu verbinden, die dazwischen ausgebildet ist und unter dem Rillenbildungsmuster (74) liegt.

3. Verfahren nach Anspruch 2, wobei in den Rillenbildungsschritten ein CO_2-Laserstrahl (14, 14A, 14B, 114) auf die innere Oberfläche (62, 80) der Abdeckschicht (58, 66, 96A, 102, 108) gerichtet wird.

4. Verfahren nach Anspruch 2, des weiteren mit dem Schritt, die Dicke (t) der Abdeckschicht (58, 66, 96A, 102, 108) an jedem Punkt entlang des Weges des Laserstrahls (14, 14A, 14B, 114) zu messen, um eine vorbestimmte verbleibende Dicke (t) der Abdeckschicht (58, 66, 96A, 102, 108) entlang des Rillenbildungsmusters (74) aufrechtzuerhalten.

5. Verfahren nach Anspruch 2, des weiteren mit dem Schritt, einen Abschnitt der Abdeckschicht (58, 66, 96A, 102, 108) komplett abzutrennen, indem ein Laserstrahl (14, 14A, 14B, 114) auf die Abdeckschicht (58, 66, 96A, 102, 108) gerichtet und relativ zu ihr bewegt wird, um den Abschnitt von ihr abzutrennen.

6. Verfahren nach Anspruch 2, des weiteren mit dem Schritt, das Abdeckstück (70, 122) mit dem Laserstrahl (14, 14A, 14B, 114) zu durchschneiden.

7. Verfahren nach Anspruch 2, des weiteren mit dem Schritt, eine Rille (22), die durch die Rillenbildung in der inneren Oberfläche (62, 80) gebildet wurde, mit einem anderen Material (24) wieder aufzufüllen.

8. Verfahren nach Anspruch 3, wobei der CO_2-Laserstrahl (14, 14A, 14B, 114) von konstanter Intensität ist und mit einer Geschwindigkeit entlang des Musters (74) bewegt wird, so daß eine gleichmäßige Rillentiefe (68) gebildet wird.

9. Verfahren nach Anspruch 3, wobei die Intensität des CO_2-Laserstrahls (14, 14A, 14B, 114) variiert wird und er mit einer kontrollierten Geschwindigkeit bewegt wird, um eine kontrollierte Tiefe und Breite der vorschwächenden Rille (74) zu erzeugen.

10. Verfahren nach Anspruch 3, wobei der CO_2-Laserstrahl (14, 14A, 14B, 114) an Intensität und/oder Geschwindigkeit variiert wird, um eine Rillenbildung in der Abdeckschicht (58, 66, 96A, 102, 108) mit einer Rille (64) variierender Tiefe zu erzeugen.

11. Verfahren nach Anspruch 2, wobei der Laserstrahl (14, 14A, 14B, 114) mit Unterbrechungen betätigt wird, um eine Rillenbildung zu erzeugen, die aus einer Reihe von durchgängigen Löchern (54, 124,

126) in der Abdeckschicht (42) oder der Substratplatte (128) besteht.

12. Verfahren nach Anspruch 2, des weiteren mit dem Schritt, einen ersten Laserstrahlgenerator (34) an einem ersten Roboterarm (36) zu befestigen, und den Roboterarm (36) zu bewegen, um den Laserstrahl (14B) des ersten Generators (34) an der inneren Oberfläche (62, 80) der Abdeckschicht (58, 66, 96A, 102, 118) entlang eines solchen Weges zu dirigieren, daß Rillen in der Abdeckschicht (58, 66, 96A, 102, 118) gemäß dem Muster (74) gebildet werden.

13. Verfahren nach Anspruch 12, des weiteren umfassend, die Abdeckschicht (58, 66, 96A, 102, 118) mit einem Meßlaserstrahl (52) zu vermessen, indem ein zweiter Lasergenerator (48) mit einem Roboterarm bewegt wird, um auf Abschnitte der Abdeckschicht (58, 66, 96A, 102, 118) entlang eines Wegs genau vor der Rillenbildung der Abdeckschicht (58, 66, 96A, 102, 118) aufzutreffen, wodurch Meßsignale in Übereinstimmung mit jeglicher Oberflächenvarianz der Abdeckschichtabschnitte erzeugt werden, des weiteren umfassend, die Rillenbildungstätigkeit, die von dem ersten Laserstrahlgenerator (34) in Übereinstimmung hiermit geliefert wird, anzupassen, um eine im wesentlichen konstante über der Rille in der Abdeckschicht (58, 66, 96A, 102, 118) verbleibende Materialdicke (t_1) zu gewährleisten.

14. Verfahren nach Anspruch 13, wobei die Bewegungsgeschwindigkeit des ersten Laserstrahlgenerators (34) in Übereinstimmung mit den Meßsignalen variiert wird.

15. Verfahren nach Anspruch 2, wobei die Abdeckschicht (58) aus einer Trokkenpulversuspension gebildet wird und eine rauhe Maserung auf der Innenoberfläche (62) aufweist, wobei der Rillenbildungsschritt eine variierende Rillentiefe (64) verursacht, die durch die Rillenbildung mittels des Laserstrahls (14, 14A, 14B, 114) in die rauh texturierte Innenoberfläche (22) gebildet wird.

16. Verfahren nach Anspruch 2, wobei das Abdeckstück (70, 122) eine geformte Lenkradabdeckung (70) aus Kunststoff aufweist, und durch die Rillenbildungsschritte vom Laserstrahl (14, 14A, 14B, 114) eine Rille (74) gebildet wird.

17. Verfahren nach Anspruch 3, des weiteren mit dem Schritt, mit dem Laserstrahl (14, 14A, 14B, 114) eine Rille in der Abdeckschicht (58, 66, 96A, 102, 118) in Querrichtung in Bezug auf die dabei gebildete Rille (22) zu bilden, um ein örtliches Vorschwächen (74) an einem ausgewählten Punkt entlang der Rille (22) zu erzeugen.

18. Vorrichtung zur vorherigen Rillenbildung in einer Innenseite (62, 80) eines inneren Abdeckstückes (70, 122) in Kraftfahrzeugen, das eine Substratschicht (98A, 108, 116) und eine darüberliegende Abdeckschicht (58, 66, 96A, 102, 118) aufweist, mit

einem CO_2-Laserstrahlgenerator (14, 14A, 14B, 114) von ausreichender Intensität, um das innere Abdeckstück (70, 122) teilweise zu durchdringen; und

Mittel (10) zum Halten des Abdeckstückes (70, 122) und zur Relativbewegung von gehaltenem Abdeckstück (70, 122) und Laserstrahlgenerator (34), um mit einem Laserstrahl (14, 14A, 14B, 114) auf dem inneren Abdeckstück (70, 122) einem Rillenbildungsmuster (74) nachzugehen, um so darin eine Airbag-Entfaltungsluke (70, 122) zu bilden;

gekennzeichnet durch Kontrollmittel (38, 44 und 50), die die Rillenbildung in dem Abdeckstück (70, 122) während des Nachgehens des Rillenbildungsmusters (74) auf dem inneren Abdeckstück (70, 122) überwachen und den Rillenbildungseffekt des Laserstrahls (14, 14A, 14B, 114) variieren, um nur ein teilweises Durchdringen des inneren Abdeckstückes (70, 122) durch den Laserstrahl (14, 14A, 14B, 114) an jedem Punkt entlang des Rillenbildungsmusters (74) zu liefern.

19. Vorrichtung nach Anspruch 18, wobei die Kontrollmittel (38, 44 und 50) Sensormittel zum Abtasten der äußeren Oberfläche der Abdeckschicht (58, 66, 96A, 102, 118) des Abdeckstückes (70, 122) umfassen, um die Rillentiefe so zu variieren, daß eine konstante Dicke (t) an verbleibendem Material aufrechterhalten wird.

20. Verfahren nach Anspruch 1, wobei bei den Rillenbildungsschritten ein CO_2-Laserstrahl (14, 14A, 14B, 114) auf die Innenoberfläche (62, 80) der Abdeckschicht (58, 66, 96A, 102, 118) gerichtet wird.

21. Verfahren nach Anspruch 20, des weiteren mit dem Schritt, die Dicke der Abdeckschicht (58, 66, 96A, 102, 118) an jedem Punkt entlang des Weges des Laserstrahls (14, 14A, 14B, 114) abzutasten und den Rillenbildungseffekt, der durch den Laserstrahl (14, 14A, 14B, 114) erzeugt wird, zu variieren, damit eine vorbestimmte verbleibende Dicke (t) der Abdeckhautschicht (58, 66, 96A, 102, 118) entlang des Rillenbildungsmusters (74) aufrechterhalten wird.

22. Verfahren nach Anspruch 1, wobei die Abdeckschicht (58, 66, 96A, 102, 118) eine Haut aufweist,

die mit einer Schaumversteifungsschicht (106, 120) vorgeformt ist.

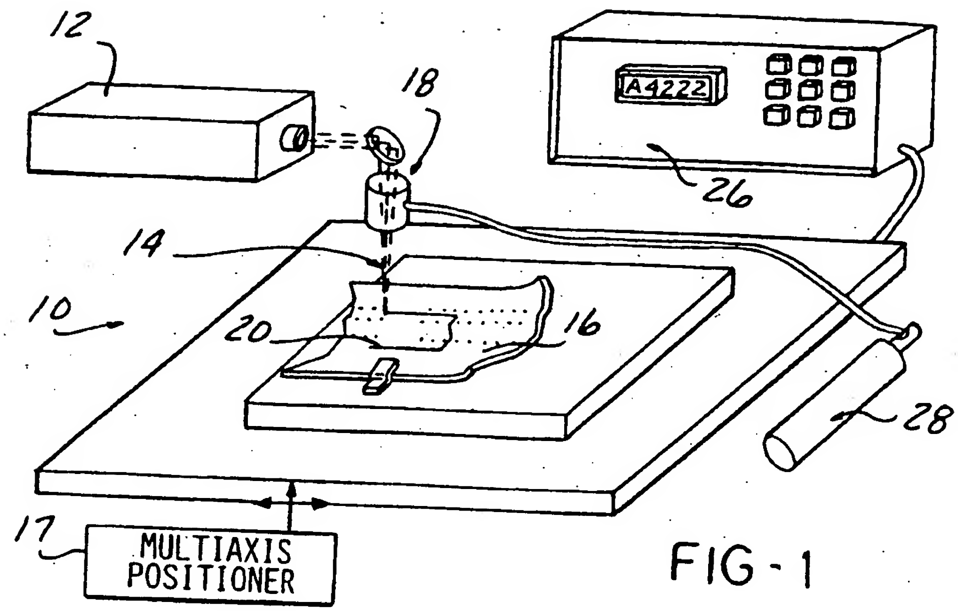

FIG-1

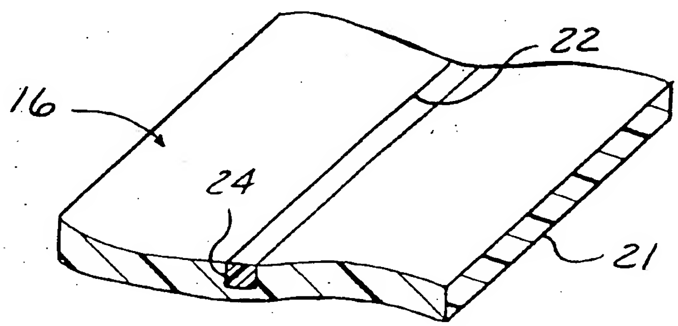

FIG-2

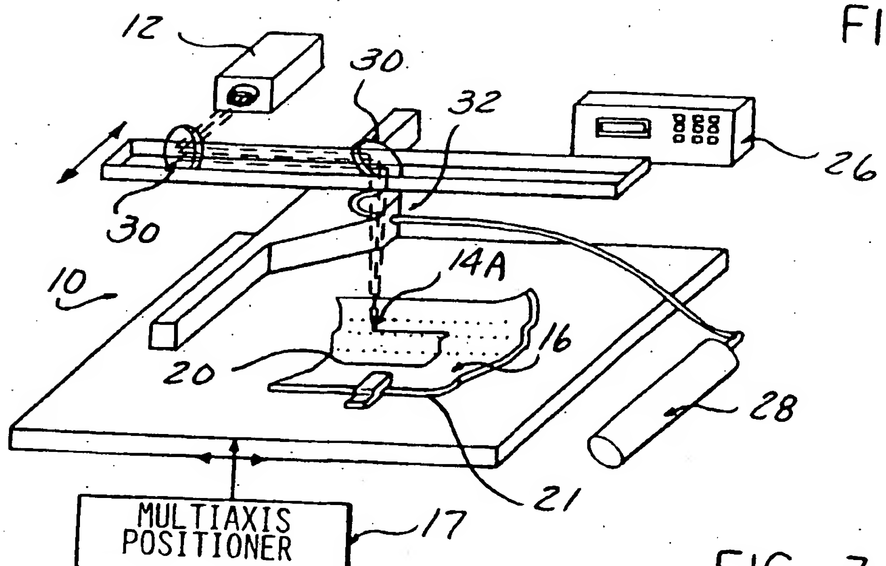

FIG-3

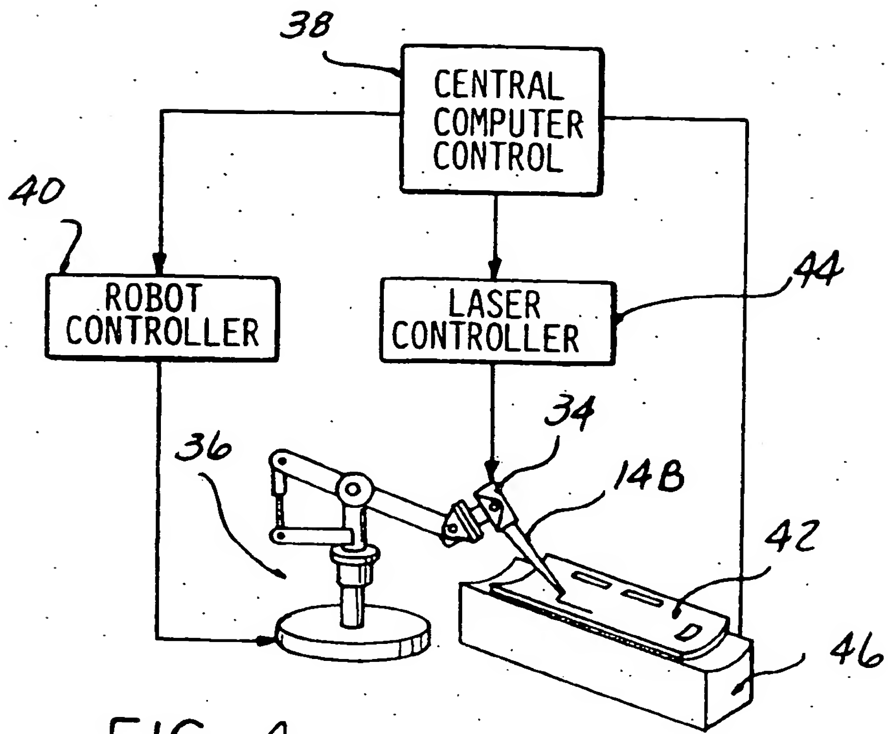
38
CENTRAL COMPUTER CONTROL
40
ROBOT CONTROLLER
LASER CONTROLLER
44
34
36
14B
42
46

FIG-4

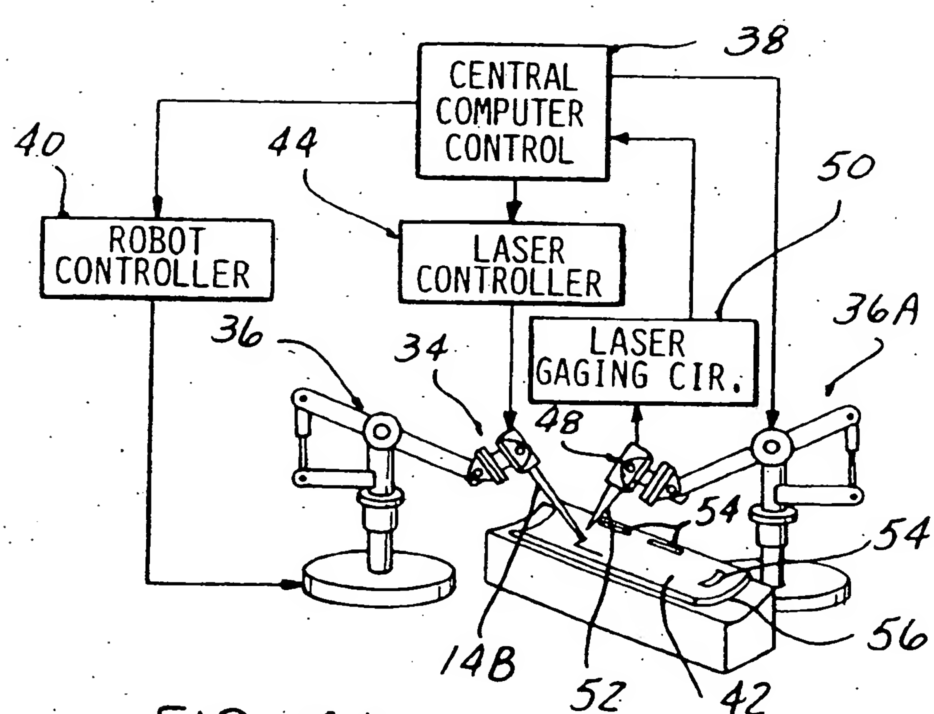
38
CENTRAL COMPUTER CONTROL
40
44
ROBOT CONTROLLER
LASER CONTROLLER
50
36A
36
34
LASER GAGING CIR.
48
54
54
56
14B
52
42

FIG-4A

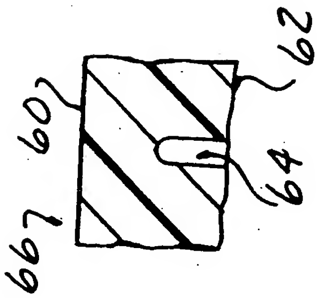

FIG-5A

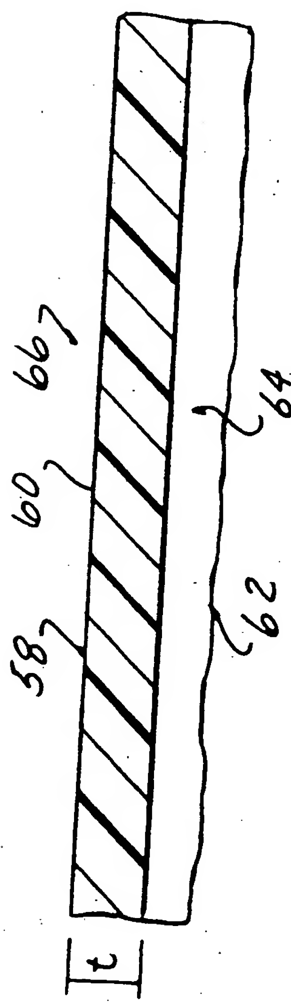

FIG-5

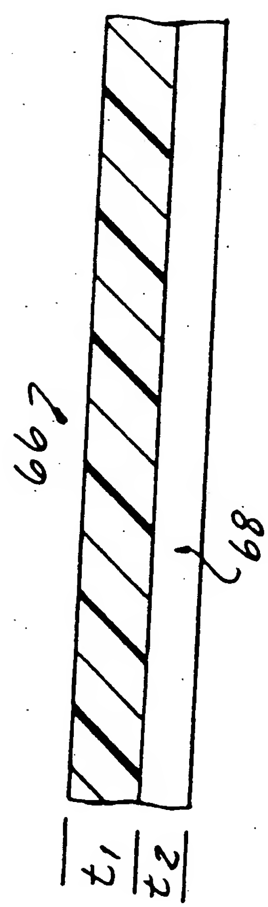

FIG-6

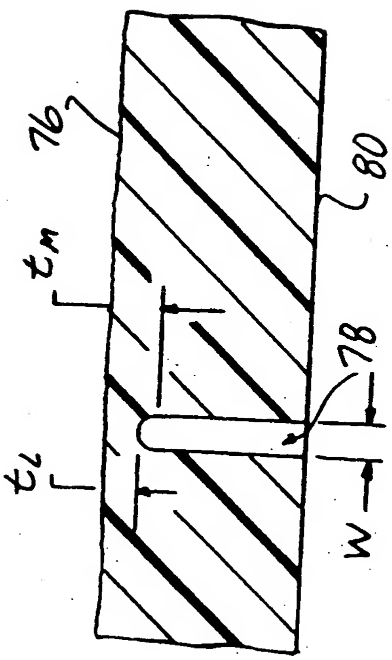

FIG-8

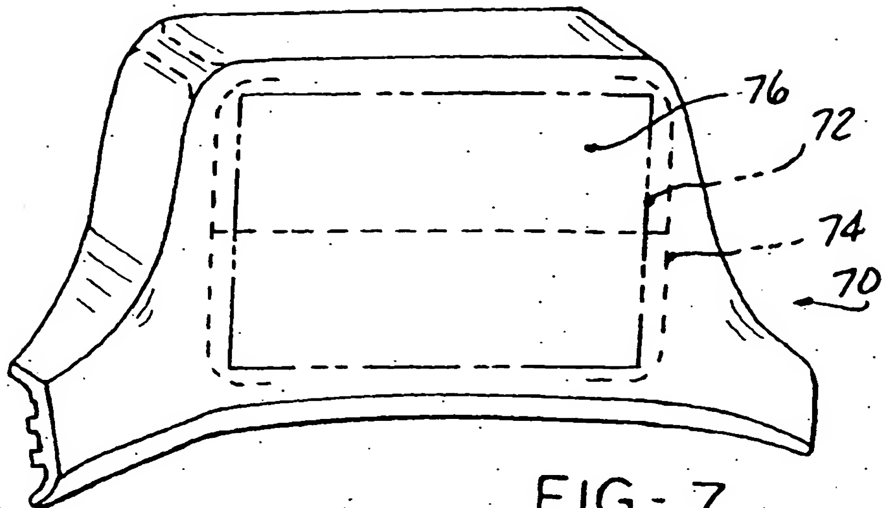

FIG - 7

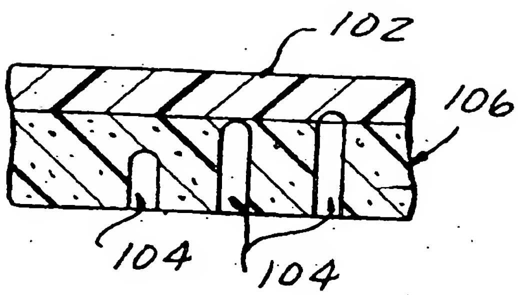

FIG - 9

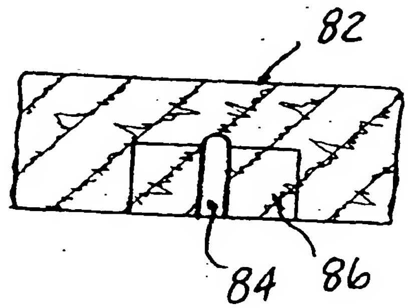

FIG - 11

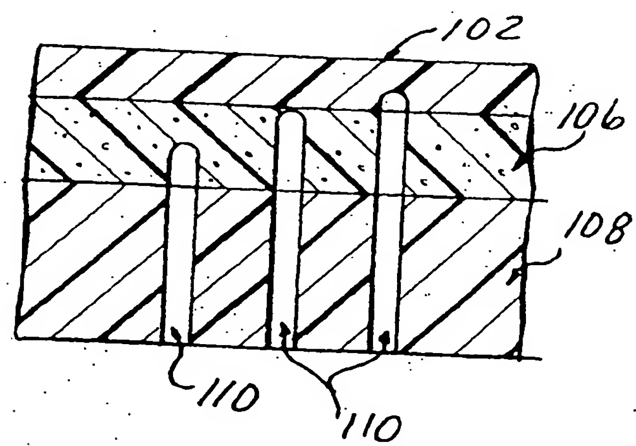

FIG - 10

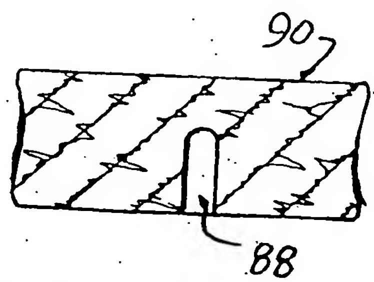

FIG - 12

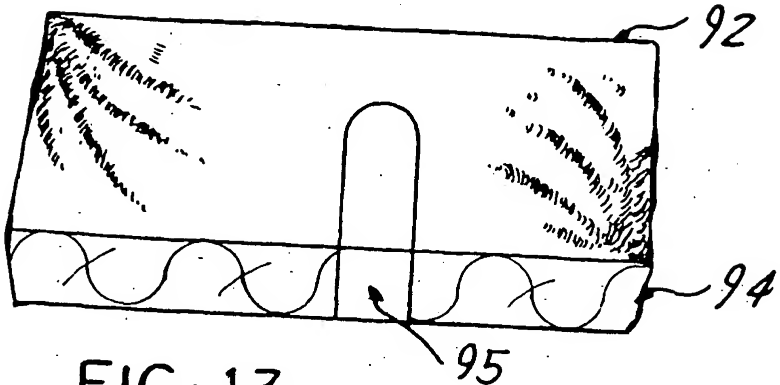

FIG-13

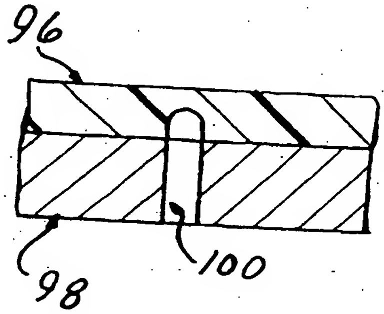

FIG-14

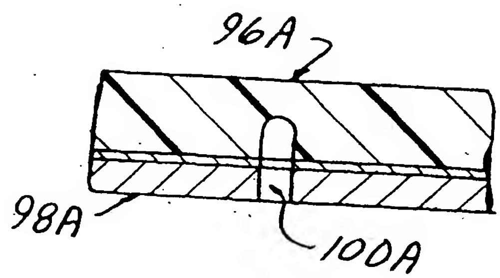

FIG-15

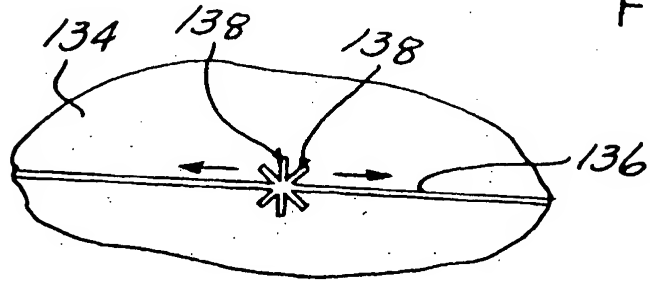

FIG-19

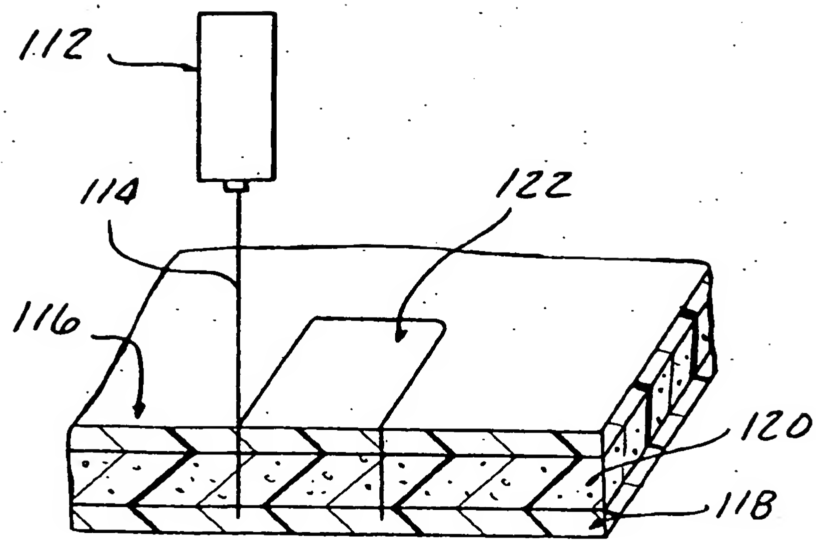

FIG-16

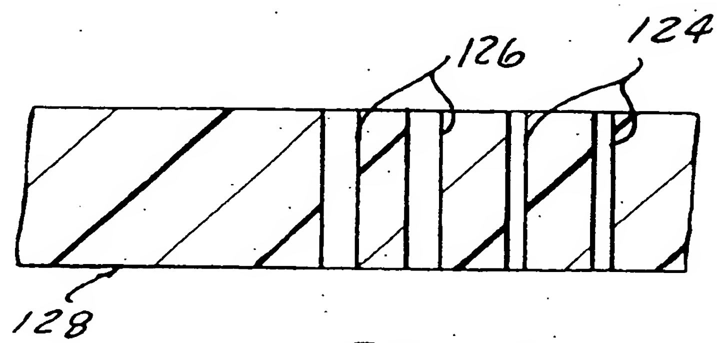

FIG-17

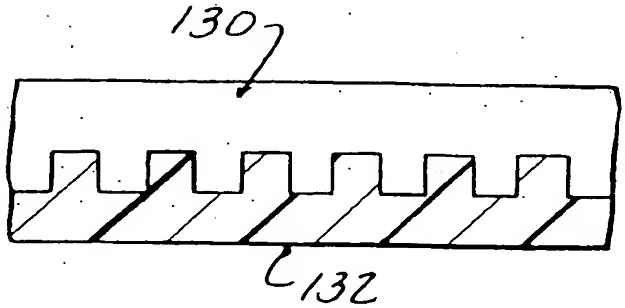

FIG-18